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THE IDENTITY OF ALL FORMS OF ANCIENT AND PRIMITIVE MEDICINE

One of the best accredited doctrines of recent times is that of the unity or solidarity of folk-ways. The mind of savage man, in its pathetic efforts to cope with hostile forces, forms religious and ethical systems for moral and spiritual guidance, or beautifies the commoner aspects of life with romance and poetry. "To primitive and modern alike, ceremonial is a shock-absorber."

The folk-ways of early medicine have been the same - an affair of charms and spells, plant-lore and psychotherapy, to stave off the effects of supernatural agencies. All anthropologists agree that the general origin of folk-ways and *mores* (religious or other) is social, concerned with the question "how to live."

"Man has climbed up from some lower animal form." There are to be found innumerable specimens of a small object in chipped flint which is the symbol of prehistoric man's uplift, his first step in the direction of civilization. With this leaf-shaped flint in hand, he had a new means of protecting himself against enemies, procuring and preparing food, and

of manufacturing other weapons and implements of the same kind or of more highly specialized kinds. Flint implements are to found wherever there are traces of the existence of man. There is apparently no distincition in space and time in the flaking of prehistoric and primitive implements. Similarly, ethnologists have found that the traditions and superstitions of primitive peoples have a strong family likeness at all times and places.

The common point of convergence of all medical folk-lore is animism, i.e., the notion that the world swarms with invisible spirits which are the efficient causes of disease and death. Primitive medicine is inseparable from primitive modes of religious belief. Medicine, in our sense, was only one phase of a set of magic or mystic processes designed to promote human well-being.

In his attempts to interpret the ways of nature, savage man, untutored because inexperienced, first of all confused life with motion. In respect of religion primitive man was an essential pantheist. Paleolithic man is usually animistic and ideographic, tends to vitalize inanimate objects. Disease, in particular, he was prone to regard at first as an evil spirit or the work of such a spirit. A further association of ideas led him to regard disease as something produced by a human enemy possessing supernatural powers. Again, his own reflection in water, his shadow in the sunlight, what he saw in dreams, or in an occasional nightmare from gluttony, suggested the existence of a spirit-world apart from his daily life and of a soul or alter ego apart from his body. In this

way he hit upon a third way of looking at disease as the work of offended spirits of the dead, whether of men, animals, or plants. With the beginnings of shamanism we have everywhere the advent of the medicine man. The shaman handles disease almost entirely by psychotherapeutic manoeuvers, he does his best to frighten away the demons of disease by assuming a terrifying aspect. To prevent future attacks, in other words, to keep the demon away for the future, he provides his patient with a special fetish or amulet to be worn or carried about his person.

We must always bear in mind that the individual savage shows the same incapacity for consecutive thought that is noticeable in the infantile, the mentally defective, and the insane.

One criterion of the savage mind is that to it only the supernatural exists. In more advanced phases, Melanesian magic implies gaining control of the _mana_ (innate power) resident in exceptional individuals protected by the barrier of taboo. The _mana_ of the Melanesian, the _manitou_ of the Algonquin, the _orenda_ of the Huron, the _wakan_ of the Sioux, are all virtually equivalent. Medicine could not begin to be medicine until it was dissociated from magic and religion. Primitive medicine stands midway between magic and religion.

It is highly probable that, in all primitive societies, priest, magician, and medicine man were one and the same. As these functions became specialized and differentiated, religion, as such came to be the

communal belief in and worship of some universal power or powers greater than man himself. Black magic was concerned with producing drought, famine, disease, death, or other evils; white magic with averting these, or with such positive good as rain-making, fire-making, or promotion of vegetation. Primitive therapy, therefore, was a mode of white magic.

Primitive pathology ascribes disease to something projected into the body of the victim. As part of this cult, the soul was regarded as "the animal inside the animal, the man inside the man." The "perils of the soul," in primitive medicine, were averted by complex systems of totems and taboos.

To the primitive, animals are supernatural beings to be feared and revered. To envelop the body with their skins, as among the ancient Gauls and Teutons or the Algonquin Indians, wards off evil influences (including disease). In the like manner, particular parts of particular animals were regarded as infallible remedies for disease. Heart, liver, and brain (the ancient "triad of life") were particularly favoured and blood was a super-remedy.

As the savage advanced a little further in the knowledge which is gained from experience, it followed that some special talent for herb-doctoring, bone-setting, and rude surgery should be developed and employed as a special means of livelihood by certain individuals. Along with these nature-healers there went, of course, the inevitable "wise woman," who followed herb-therapy and midwifery, and such specialists soon perceived

not only what substances are good or harmful as foods, but that a number of poisons are also remedies under various conditions.

Early man regarded the poisoner with the same horror and loathing that we feel. At the ancient Greek festival of the Thargelia, given at Athens every May, two public outcasts, set apart for the purpose, were flogged with squills, wild fig-branches or agnus castus, and possibly stoned to death or flung into the sea. The scapegoat, in this case, was called the Pharmakos, originally a sorcerer or poisoner.

Primitive man's knowledge of medicinal simples was exactly like the drug phase of our modern therapeutics. The ancient Egyptians, Chinese, and Aztecs had botanic gardens (Hill). We find that savages in widely separated countries easily get to know the most fatal arrow-poisons - curare, ouanain, veratrin, boundou - as well as the virtues of drugs like opium, hashish, hemp, coca, cinchona, eucalyptus, sarsaparilla, tobacco, acacia, kousso, capaiba, guaiac, jalap, podophyllin, or quassia.

It is plain that primitive man, in spite of his ill-ventialated habitations, kept healthy through his hardy life in the open air, and had advantages which his civilized brother often seeks or finds only on compulsion. The Indian sensed, for example, the importance of keeping the skin, bowels, and kidneys open, and, to this end, the geyser, the warm spring, and the sweat-oven were his natural substitutes for a Turkish bath. Polynesian massage is apparently a true rational therapeutic measure. Hypnotism

originated among the Hindus; inoculation against smallpox among the Hindus, Persians, and Chinese. The Chinese of the Mongol dynasty (1260) probably learned of the use of spectacles from India via Turkestan.

The earliest surgical instrument was, in all probability, not the specialized leaf-shaped flint or "celt", already referred to, but rather some fragment, unusually sharpened as to edge and point by accidental flaking, as in the obsidian knives of Peru. By means of these sharpened flints or of fishes' teeth, blood was let, abscesses emptied, tissues scarified, skulls trephined, and, at a later period, ritual operations like circumcision were performed. Decompressive trephining for epilepsy or other cerebral disorders goes back to prehistoric times. It was common among neolithic Gauls and Bohemians. A remarkable variant of it is the ritual crosswise mutilation along the lines of the coronal and sagittal sutures. Primitive man's wounds were dressed with moss or fresh leaves, ashes or natural balsams, and, when poisoned, treated by sucking or cauterization. Cupping was effected by means of animals' horns. For couching a cataract or opening an abscess, even a sharp thorn sufficed. The Dayaks of Borneo employ a sharp root (pinjampo). During the Bronze and Iron Ages, expert skill in metal work became an accomplished fact, and surgical instrumentation was correspondingly improved. The real beginnings of North-European culture are now held to be the metal implements and objects found

at La Tène. The La Tène finds, dating from about 500 B.C. to 100 A.D., are entirely distinct from Egyptian, Indian, or Greek culture, and include iron knives, needles, fibulae, swords and lances, with bracelets, necklaces, and ear-rings of Etruscan or West Celtic pattern, and funeral urns containing human remains. With improved metal instruments, such cosmetic operations as tattooing, infibulation, boring holes for ear-rings and nose-rings, or the Mica operation (external urethrotomy), as well as amputation and lithotomy, could be essayed. The ancient Hindus performed almost every major operation except ligation of the arteries.

The use of a soporific potion, as a substitute for anaesthesia, goes back to remote antiquity - the nepenthe of the Odyssey, the _samme de shinta_ of the Talmud, the _bhang_ of the Arabian Nights, opium, Indian hemp, mandrake, henbane, dewtry, hemlock, and lettuce were recommended for surgical anaesthesia by the mediaeval masters in the form of a _spongia somnifera_ or _confectio soporis_. Again, the use of such natural antiseptics as extreme dryness, smoke (creosote), honey, niter, and wine was common to early man.

In the field of obstetrics, we find the midwife to be one of the most ancient of professional figures. The obstetric chair appears to be of great antiquity.

The beginnings of treatment were ~~therefore~~ empirical observations on dietetics. Hippocrates notes the advantages of restricted and slop diet in illness, the disadvantages of coarse cereals, of unseasonable abstinence or

repletion.

We now come to a phase of primitive healing which is intimately connected with even the most recent aspects of the subject, namely, the potency of therapeutic superstitions and the actual cure of disease through the influence of the mind upon the body. "Nature cures the disease while the remedy amuses the patient". "Feeling travels along the line of least resistance, while thought, or the challenge by inquiry, with its assumption that there may be two sides to a question, must pursue a path obstructed by the dominance of taboo and custom, by the force of imitation and by the strength of prejudice, passion and fear."

Ancient sacrifice was sometimes honorific (hostia honararia), a gift to the god; sometimes cathartic or piacular (hostia piacularis).

The idea of material regeneration or new-birth is of Hindu (Aryan) origin and sprang from the primitive worship of the generative power of nature. A cloven tree or a hole in a rock was regarded as symbolic of the sacred yoni.

In folk-lore and common usage, each primary colour has associations all its own.

The idea that certain numerals may be sacred or malignant is of Accadian origin. The known periodicity of epidemic diseases from year to year justified the old Chaldaic superstition of the "evil year". Another superstition deriving from Chaldean astrology was the belief that

the heavenly bodies influence disease. "To coerce the spiritual powers, or to square them and get them on our side," says William James, "was, during enormous tracts of time, the one great object in our dealings with the natural world." In process of time, medical polytheism merged into monotheism. Of a piece with this theory of disease was the benign or malign power which was supposed to attach to certain personalities. A child born on Easter Eve could cure tertian or quartan fever. Persons born "with a caul" were supposed to be clairvoyant. The power to heal scrofula by Royal Touch was part and parcel of the divine right of kings. The medical lore of holy men, their special days, the diseases they presided over, the holy wells and other things blessed by them, form a special field in itself. The saints were supposed, as usual, to have the power both of inflicting and healing diseases, most of which were, however, associated with the names of several saints. Thus the names of St. Guy, St. Vitus, and St. With are eponymic for chorea; St. Avertin, St. John, and St. Valentine stood sponsors for epilepsy; St. Hubert of Ardennes, the patron of huntsmen, cared for hydrophobia, while St. Anthony, St. Benedict, St. Martial and St. Genevieve presided over ergotism.

A remarkable example of belief in the malevolence of personality is the superstition of the Evil Eye. There is a strong human prejudice against disconcerting, intensive, or forbidding appearances of the eye.

An essential part of the theory of divine or personal influence is the doctrine of amulets and talismans and, of course, the appropriate

charms and spells that go with them. Tylor has shown that the brass objects on harness were originally Roman amulets.

The folk-lore of stones is of great antiquity. The oldest prescription in existence - that discovered in Egypt by W. Max Müller - displayed in the Museum of Natural History in New York, calls for the exhibition of a green stone as a fumigation against hysteria. "Scopelism," the ancient Arabic custom of piling up stones in a field, either to prevent its tillage or as a menace of death to the owner, is to be found everywhere as a symbol of the hatred of Cain for Abel, of the outlaw for the worker, of the barbarian for civilization. Precious stones came to be esteemed, in the first instance, no doubt, for their rarity, but equally for their supposed potency against disease.

Talismans were often written charms or "characts," such as the Hebrew phylacteries, or verses from the Bible, Talmud, Koran, or Iliad.

In many neuroses or in neurotic individuals, there is indubitable evidence of the effect of the mind upon the body, and in such cases it is possible that a sensory impression may so influence the vasomotor centres or the internal secretions of the ductless glands as to bring about definite chemical changes in the blood, glands, or other tissues, which, in some case, might consitute a "cure". "Since Pawlow and his pupils have succeeded in causing the secretion of saliva in the dog by means of optic and acoustic signals, it no longer seems strange to us that what the philoso-

pher terms an 'idea' is a process which can cause chemical changes in the body". Crile's important studies of surgical shock show the strong analogy existing between the phenomena produced by shock, the extreme passion of fear, and the symptom-complex of Graves' disease. W. B. Cannon shows that in fear, rage, anger, or any emotions which prepare the animal for fight or flight, the digestive and sexual functions are immediately inhibited, the adrenal secretion is rapidly poured into the blood, mobilizing sugar from the hepatic glycogen up to the point of glycosuria, counteracting the effects of muscular fatigue, and hastening the coagulation time of the blood, thus giving the organism a heightened capacity for offence, defence, flight, and repair of injured tissues. Extreme mental irritation or depression may superinduce dyspepsia, jaundice, chlorosis, or general decline. Fright has produced cardiac palpitation, and heart-failure may result from a shock due to a set-back in business. Rage may induce anything from precordial spasm up to angina pectoris, as in the case of John Hunter. "The best inspirer of hope is the best physician," - to "minister to the mind diseased" by removing the splinter of worry or misery from the brain in order to restore the patient to a cheerful state of mental equilibrium. It is also the secret of the influence of religion upon mankind, and here the priest or pastor becomes, in the truest sense, <u>ein Arzt der Seele</u>.

Certain beliefs and superstitions have become ingrained in humanity through space and time, and can be eradicated only through the kind of public enlightenment which teaches that prevention is better than cure.

The history of the advancement of medical science, however, is the history of the discovery of a number of important fundamental principles leading to new views of disease, to the invention of new instruments, procedures, and devices, and to the formulation of public hygienic laws.

PREHISTORIC PHASES

Whether the human race is descended from several distinct anthropoid species, or from a single ancestor, common to man and the anthropoid apes, is lost in the dark backward and abysm of time. The prehistory of man begins with the origins of anthropoid life in the Oligocene, the transformations of ape-men into men in the Pleiocene, the extinction of the great mammals, and the dawn of the Old Stone Age culture in the Pleistocene.

In the late Pleiocene or early Pleistocene (first interglacial period) appeared the ape-man (Pithecanthropus erectus, 500,000 B.C.), whose remains were excavated by Dubois at Trinil River, Java (1891). In the Middle Pleistocene (second interglacial period) came the Heidelberg man (Palaeoanthropus, 1907). He was followed in the late Pleistocene (third interglacial period) by the Piltdown man (Eoanthropus Dawsoni, 1911); a little later (in Africa) by the gorilla-like Rhodesian man (1921); at the close of the glacial period (about 120,000 B.C.), by Neanderthal man. About 20,000 B.C. came Crô-Magnon man (Homo sapiens 1868), and about 20,000 B.C., the subvariety of Crô-Magnon known as Predmost man (1880).

The great step forward was the setting free of the hand and foot as the Dawn Man (Pithecanthropus) abandoned the arboreal status of the smaller monkeys, in consequence of increased height and weight. The marks of the

beast, the receding forehead, the ponderous supraorbital ridge, the wide orbits, broad flat nose, heavy simian jaw, fang-like teeth, long arms, and vaulted back, were still there, but, by 25,000 B.C., Crô-Magnon man, the "Paleolithic Greek," had already acquired a rude nobility of stature and countenance, had learned to make weapons, tools and clothes, to domesticate cattle, to bridle horses, and to cultivate wild wheat. He buried his dead in sepulchres, trephined the skull, used cranial amulets and other personal adornments, knew how to dance and, in the Aurignacian period, was a skilled painter and sculptor. At the same time, the gap between Paleolithic and Neolithic man is much greater than that between Later Stone Age man and the peoples of Egypt and Mesopotamia. In the Mousterian (Neanderthal) period, prehistoric man was probably more ape-like than the Australian savage. In the Aurignacian (early Crô-magnon) period (25,000-20,000 B.C.) he was taller, cleaner limbed and bigger brained than we are. In the Solutrean period (20,000-15,000 B.C.) there were types like the Bushmen; in the Magdalenian (15,000-10,000 B.C.) there were people who resembled the Mongolians and the Esquimaux.

The earliest known representation of the human figure, the Venus of Willendorf, found by Szombathy (1908) in the loess of the Middle Aurignacian Period (22,000 B.C.), is a limestone statuette of a Paleolithic woman, 4½ inches high, which conveys all the implications of endocrine obesity, and is thus a definite contribution to constitutional (external) anatomy. Figurations of the prehistoric male, on the other hand, have the

inevitable straight flanks, narrow hips, and serviceable musculature of the athletic warrior-huntsman (limestone bas-relief at Laussel).

What were the primary reactions of prehistoric man to wounds? He would crawl to shelter and quietude.

Bloody sacrifice by the tribal priest was an apotropaic rite of the whole tribe against the entire horde of disease demons, and there were also incantations against disease-demons.

Prehistoric trephining was performed, in the way already described, by Neolithic man 10,000 years ago, usually for headache, probably for epilepsy, insanity and, what he most feared, blindness. The philosophy of cerebral decompression was to release or drive out the demon. Amputation of the fingers, another superstitious rite, goes back to the late Paleolithic (Aurignacian) Period, perhaps 25,000 years ago. The earliest known diseases to which prehistoric man was exposed were probably those which affected and, perhaps, helped to exterminate, the Mesozoic reptiles and the later fossil mammals, viz., necrosis, exostoses, and other bony lesions, the arthritides, including rheumatoid arthritis and spondylitis deformans, and diseases of the teeth. The femur of the Javanese Pithecanthropus shows marked exostoses; the skull of Piltdown man (Eoanthropus), signs of acromegaly or of osteitis deformans. The left ulna of the original Neanderthal skeleton is fractured and, in the opinion of Virchow, the left humerous rhachitic. The spine of Heidelberg man (7000 B.C.) shows signs of Pott's disease, which is also common in later Egyptian mummies.

Pathogenic parasitism was evolved from easy going commensalism and symbiosis in the Cambrian period. The earliest known bony tumor (hemangioma) was found in a Mesozoic dinosaur of Wyoming. The aquatic mosasaurs and plesiosaurs of the Kansan Cretaceous show osteoperiostitis, osteoma, arthritides, and dental caries. In this period there is a definite correlation between focal infection (pyorrhea) and arthritis (spondylitis) deformans. Actinomycosis is probable in the jaw of a three-toed horse of the South Dakotan Miocene. Fossil tsetse-flies (Glossina) in the Colorado Oligocene suggest the possibility of nagana in early Tertiary ungulates.

In Neolithic man, the cave-gout (Höhlengicht) of Virchow (arthritis deformans) is as common in Egyptian mummies as in the skeletons of the primaeval Teutonic forests or the cave-bears of the Pleistocene. Peruvian pottery conveys striking representations of uta, goundou, verruga Peruviana, achondroplasia, and spinal deformities. North American Indian remains of the pre-Columbian period reveal the usual impact of inflammation upon the bones (osteitis) and joints (arthritides), and some of the pottery again depicts Pott's disease and spinal deformities.

EGYPTIAN MEDICINE

The oldest historic phase of medicine known to us is that of ancient Egypt. Consideration of the finds from the Old Kingdom (3400-2440 B.C.), the Middle Kingdom (2440-1580 B.C.) and the New Empire (1580-1200 B.C.) reveals the continuous development of a highly specialized and eventually sophisticated civilization.

It is probable that many phases of Egyptian culture were spread, even to the New World, by the mechanical process of convection, as Elliot Smith maintains.

The so-called heliolithic culture included sun-worship and its symbols; the building of megalithic monuments and the rearing of gigantic stone images; the practice of mummification, or embalming the dead, even among the North American Indians (H.C. Yarrow), the practices of tattooing (Miss Buckland), piercing the ears (Park Harrison), massage (W. H. R. Rivers), circumcision, etc., may have influenced the early Minoan civilization of Crete after 2800 B.C. After 900 B.C. the Phoenician navigators may have been the middlemen, while the giant craft of Malaysia and Polynesia ~~may have~~ carried it from the mainland of Asia to the Americas.

Our main sources of Egyptian medicine are the medical papyri, but antedating even these are the well-splinted fractures of the 5th dynasty (2750-2625 B.C.) and certain pictures, engraved on the doorposts of a tomb in the burial ground near Memphis and regarded by their discoverer, W. Max

Müller, as the earliest known pictures of surgical operations (2500 B.C.). Although we have reasons for believing that the Egyptians never carried surgery to the extent of opening the body, yet here are clear and unmistakable representations of circumcision and possibly of surgery of the extremities and neck. Apart from this, there is no evidence of surgery except in the splints found on the limbs of mummies of all periods.

The medicine chest of an Egyptian queen of the 11th dynasty (2500 B.C.), containing vases, spoons, dried drugs and roots, is an unusually important find. There are many statuettes of the earliest known physician Im-hotep ("He who cometh in peace"), a medical demigod, the Aesculapius of King Zoser's reign (3d dynasty 2980-2900 B.C.). A statue of the physician Iwte of the 19th dynasty (1320-1170 B.C.), is in the Imperial Museum at Leyden.

The principal papyri are the Papyrus Ebers, translated by H. Joachim (1890), the Westcar (Lesser Berlin) Papyrus, translated by Adolf Erman (1890), the Kahun papyri of the Petrie collection, translated by F. L. Griffiths (1893), the Brugsch (Greater Berlin) Papyrus (1300 B.C.) and the badly preserved London Papyrus, both translated by Walter Wreszinski (1909, 1910), and the Hearst (Philadelphia) Papyrus, containing about half the text of the Papyrus Ebers. The Edwin Smith Papyrus (1600 B.C.), translated by J. H. Breasted, is mainly surgical. The Gardiner Papyrus is gynecological. The oldest papyri are the gynecological and veterinary scripts of the Petrie Collection from Kahun (1893), which date back to the Middle Kingdom (2160-1788 B.C.).

The most valuable medical papyrus in respect of actual content is that acquired by Edwin Smith (1822-1906). The Edwin Smith Papyrus (1600B.C.) is a roll over 15 feet (4·68 meters) long, written on both sides.

The next most important of the medical papyri is that obtained by Georg Ebers at Thebes in 1872, which dates back to about 1550 B.C. Ebers himself supposed it to be one of the lost sacred or Hermetic Books of Thoth. It begins with a number of incantations against disease and then proceeds to list a large number of diseases in detail, with some 875 recipes, and 47 diagnosed cases. The most interesting parts are the extensive sections on the eye and ear, and the descriptions of the ĀĀA disease, which have been thought by Joachim to be identical with different stages of the hookworm infection. In addition to the hookworm, Filaria, Taenia, Ascaris, and other parasites are mentioned and prescribed for. The large number of remedies and prescriptions cited in the Papyrus suggests a highly specialized therapeusis. In the late period Egyptian therapy must have been, of necessity, haphazard, since, as we shall see, each Egyptian physician was a narrow specialist, confining himself to one disease or to diseases affecting one part of the body only. Egyptian gynecology and obstetrics have been studied in the five principal papyri by Felix Reinhard.

The most interesting part of the Ebers Papyrus is the last section of all, which treats of tumors. Here, as in the description of the ĀĀA disease, we find some approach to the accurate clinical pictures of Hippocrates.

Later Egyptian medicine was entirely in the hands of priests, while Greek medicine, even at the time of the Trojan War, would seem to be entirely independent of priestly domination. From Herodotus we learn of the hygienic customs of the Egyptians, the gods of their worship, their ideas about medicine, and their methods of embalming dead bodies. "The art of medicine," says Herodotus, "is thus divided among them: Each physician applies himself to one disease only, and not more."

The paleopathology of Egypt was first investigated by Fouquet in 1889. In 1907, the Egyptian government instituted an archaeological survey of that part of Nubia which would be susequently flooded by the raising of the Assuan dam. The anthropological and pathological phases of the investigation were entrusted to G. Elliot Smith with the assistance of F. Wood Jones and others.

The main interest of Egyptian medicine lies in its proximity and relationship to Greek medicine. The word "chemistry" itself is derived from chemi (the "Black Land"), the ancient name of Egypt, whence the science was called the "Black Art." But Egyptian medicine, like Egyptian art, was fated to go backward as the centuries advanced. Long before the Alexandrian period, Egyption civilization had become absolutely stationary in character and, in the Alexandrian period, Egypt's physicians were going to school in Greece.

SUMERIAN AND ORIENTAL MEDICINE.

Mesopotemia was the starting-point of Oriental civilization, of which the Babylonians were undoubtedly the principal founders. They invented the cuneiform inscriptions, reading from left to right.

It is said that astronomy is the oldest of the sciences, and in all early civilizations we find it applied to the practical affairs of life as astrology. This trait, symbolized in the Sumerian boundary stone with its zodiacal signs (1185 B.C.), is the essence of Assyro-Babylonian medicine. Astrology and the interpretation of omens merged into prognosis and, as with all early civilizations, the first Babylonian physician was a priest or the first priest a physician. Inspection of the viscera, an essential part of augury, led to inspection of the urine and, among the Babylonians, soothsaying was concentrated upon the liver, terra-cotta models of which, about 3000 years old, have been found. Neuburger points out how the priestly interest in omens might have led to the collection and collocation of clinical observations. For the most part, however, the Babylonian physicians regarded disease as the work of demons, which swarmed in the earth, air and water, and against which long litanies or incantations were recited.

With the Babylonians, as Montaigne quaintly observes, "the whole people was the physician."

The outstanding achievement of the Assyro-Babylonians in public hygiene was their perception of the transmissibility of leprosy, which took the practical line of expulsion of lepers from the community. Excavations of the huge Babylonian drains, of which models were exhibited at the Dresden Exposition (1911) and at the Gesolei at Düsseldorf (1926), show that they understood the proper disposal of sewage. A stone privy in the palace of Sargon at Chorsabad (1300 B.C.) has been excavated.

Persian medicine is, like Indian medicine, a phase or offshoot of Aryan tradition, and is part of the cult of Zoroaster (1000 B.C.), as conveyed in the Zendavesta (the Bible of the Parsee) and the Vendidad (Book of the Law). Ancient Persian medicine, as distinguished from Oriental phases of medicine in Persia, is mainly of interest for its likeness to or influence upon Jewish medicine.

Closely connected with Sumerian-Semitic medicine in point of time is the medicine of the Jewish people, in relation to the Assyrian captivity (722 B.C.) and the Babylonian captivity (604 B.C.). The principal sources of our knowledge of Jewish medicine are the Bible and the Talmud. In the Old Testament, disease is an expression of the wrath of God, to be removed only by moral reform, prayers, and sacrifice; there is not a single reference in the Bible to priests acting as physicians.

The principal interest in Biblical diseases lies in the remarkable efforts made to prevent them. The ancient Hebrews were, in fact, the founders of prophylaxis, and the high priests were true medical police.

The chief glory of Biblical medicine lies, as Neuburger rightly says, in the institution of social hygiene as a science.

In contradistinction to the written Mosaic law in the five books of the Pentateuch (Torah), the Talmud consists of the law as transmitted by verbal tradition (Mishna), with its several interpretations and commentaries (Gemara). This mass of knowledge began to accumulate after the Babylonian Captivity, about 536 B.C., and is embodied in the Palestinian Talmud (370-390 A.D.) and the Babylonian Talmud (352-427 A.D.), the latter being the ordinary source of reference. Anatomy of any kind before the time of Vesalius was a thing of shreds and patches. In the Talmud the number of bones in the skeleton is variously estimated at 248 or 252, and of these, one, the bone Luz, was regarded as the indestructible nucleus from which the body is to be raised from the dead at the Resurrection. Diphtheria, known as askara (ἐσχάρα) or serunke (σύναγχη, cynanche), was so much feared by the Hebrews that the first case located in a community was immediately heralded by a warning blast of the shofar, although the instrument was ordinarily sounded only after the occurrence of the third case of an infectious disease. Talmudic surgery included the usual "wound-surgery," with treatment by sutures and bandages, applications of wine and oil, and the device of freshening the edges of old wounds to secure more perfect union. Venesection, leeching, and cupping were common and, before attempting the major operations, a sleeping draught (samme de shinta) was administered. The

earliest known reference to hemophilia is, perhaps, the dispensation in the Babylonian Talmud (Jebamoth, 64b), which interdicts circumcision if fatal in two successive children, as indicating a family of bleeders. Caesarean section, excision of the spleen, amputations, trephining, and the operation for imperforate anus in infants were known, as also the use of the speculum and the uterine sound.

As the Hebrews attained the highest eminence among Oriental peoples in hygiene, so the ancient Hindus excelled all other nations in their time in operative surgery. In the earliest Sanskrit documents, the Rig Veda (1500 B.C.) and the Athara-Veda, medicine is wholly theurgic, and treatment consists of the usual versified spells and incantations against the demons of disease. In the Brahminical period (800 B.C. - 1000 A.D.), medicine was entirely in the hands of the Brahmin priests and scholars, and the centre of medical education was at Benares. The three leading texts of Brahminical medicine are the Charaka Samhita, a compendium made by Charaka (2d century A.D.) from an earlier work of Agnivéra, based upon the lectures of his master Atreya (6th century B.C.), the Suśruta (5th century A.D.) and the Vagbhata (7th century A.D.). Indian medicine was particularly weak in its anatomy. Diagnosis was carefully made, and included inspection, palpation, auscultation, and the use of the special senses. Semeiology and prognosis combined acute observation with the usual folk-superstitions. As examples, witness

the Suśruta's very recognizable description of malarial fever, which is attributed to mosquitos, or the passage in the Bhâgavata Purana which warns people to desert their houses "when rats fall from the roofs above, jump about and die." Essential diabetes mellitus was recognized as Madhumeha or "honey-urine." Evidences of variolation (inoculation against smallpox) have been found in the Sanskrit text Sacteya, or attributed to Dhanwantari. In therapeutics, a proper diet and regimen were carefully detailed, and baths, enemata, emetics, inhalations, gargles, blood-letting, and urethral and vaginal injections employed. The materia medica of India was particularly rich. The soporific effects of hyoscyamus and Cannabis indica were known, and their employment in surgical anaesthesia was, according to Burton, of great antiquity. In the obstetric chapter of the Suśruta, there is an admirable section on infant hygiene and nutrition. The surgical arm of treatment in India reached, as we have said, the highest point of development attained in antiquity. The Suśruta describes about 121 different surgical instruments. The Hindus apparently knew every important operative procedure except the use of the ligature. They treated fractures and dislocations by a special splint made of withes of bamboo. They performed lithotomy (without the staff), Caesarean section, excision of tumors, and the removal of omental hernia through the scrotum. Their mode of couching for cataract has survived to the present day, and they were especially strong in skin-

grafting and other phases of plastic surgery. They were especially clever in their method of teaching surgery.

With the Mohammedan conquest, Indian medicine passed under the sway of the Arabic domination, and its influence declined.

Until recently Chinese medicine has been what our own medicine might be had we been guided by mediaeval ideas down to the present time, that is, absolutely stationary.

Ancient Chinese medicine is purely legendary. The emperor Shen Nung (2737 B.C.), the putative father and founder, is said to have originated the Chinese materia medica by experimenting with poisons and classifying medical plants. To him is attributed the Pentsao (Great Herbal), and to emperor Huang-ti (2697 B.C.), the Neiching (Canon of Medicine). The ideogram for "physician" (pronounced i) contains, like the Egyptian hieroglyph, an arrow or lancet in the upper half and a drug- or bleeding-glass in the lower.

It was in the Han dynasty (202 B.C. - 263 A.D.) that Chinese medicine began to advance through the work of Tsang Kung (170 B.C.), who was the first to record clinical cases, Chang Chung-Ching (195 A.D.), author of treatises on dietetics and fevers (Shang-han-lun), and Hua To, the most famous surgeon of China, who is said to have employed Cannabis indica for anaesthesia. Desire for long life (shou) led the Taoists to the search for the Golden Pill (chin tan) or aurum potabile (elixir of life), whence alchemy became a cult of long duration. A remarkable work of the Sung Dynasty is the Hsi Yüan Lu (1241-43) or Instructions to

Coroners, a compilation giving minute directions for the examination of a corpse before or after burial, the signs of wounds, blows, strangulation, suicide, poisoning, with directions for resuscitation and antidotes for poisons. It was the official text of forensic medicine for hundreds of years. Physical anthropometry is clearly of Chinese origin. Angiology and osteolggy were cultivated as topographic aids to acupuncture (2697 B.C.), cauterization and osteopathy.

Chinese anatomy and physiology are dominated by the Neiching, with its strange antinomies of a fantastic number-lore and an exact physical anthropometry. Each organ is related to a colour, taste, season, and time of the day, has a parent and friends and enemies. With such inadequate knowledge of human structure and function there could be very little surgery, particularly among a people whose religious convictions were against the drawing of blood or the mutilation of the body. Castration is the only operation they perform and, while they use dry cupping and massage, they do not resort to venesection, but substitute the moxa and acupuncture. The moxa, probably introduced into Chinese and European practice from Egypt, consists of little combustible cones which are applied all over the body and ignited. Acupuncture is the pricking of the body with needles, coarse or fine, which are sometimes twisted in the stretched skin. The Chinese were wonderfully clever at massage, and were the first to employ the blind as masseurs. They were early acquainted with identification by finger-prints (dactyloscopy).

Michael Boym, a Jesuit missionary in China, first wrote on Chinese pulse-lore (1666), giving plates representing their peculiar mode of feeling the pulse. The Chinese materia medica is unusually extensive. It includes such well-known drugs as ginseng, rhubarb, pomegranate root, aconite, opium, arsenic, sulphur, and mercury (for inunction and fumigation in syphilis), and many disgusting remedies, such as the parts or excreta of animals. Syphilis in China is said to go back to the Ming dynasty, and references to gonorrhea are attributed to Huang-ti. The ancient Chinese knew of preventive inoculation against smallpox, which they probably got from India. The three religions of China counsel inaction and meditation, indeed, public opinion in the East is, as Cowdry affirms, a narcotic rather than a stimulant. Modern medicine has been developed in China through the hospitals and medical schools established by the foreign missionaries.

The Japanese are noted for their remarkable power of assimilating the culture of other nations, and, before they came in contact with European civilization, their medicine was simply an extension of Chinese medicine. Up till 96 B.C., Japanese medicine was passing through the mythical phases common to all forms of early medicine. The period 96 B.C. - 709 A.D. marks the ascendancy of Chinese medicine. During the succeeding periods (710-1333), called the "Nara", "Heian," and so on, after the names of the different capitals of Japan, the influence of the Chinese priest-healers was still dominant. The oldest Japanese medical book, the Ishinho, written by Yasuhori Tambu in 982, describes some surgical novelties, and also records the existence of lying-in

hospitals and isolation houses for smallpox patients. With the arrival of St. Francis Xavier in 1549 begins the rise of European influences. The modern or Meiji period of Japanese medicine begins with the year of revolution, 1868. Its distinctive feature is the rise of Germanic influences.

GREEK MEDICINE

I. Before Hippocrates

In the time of Grote, Greek history began with the first Olympiad (776 B.C.). Today, the origins of Greek civilization go back to at least 3400 B.C., and are found outside the Greek peninsula. The Minoan civilization of Crete, which goes back to Neolithic man, was revealed in the excavations of Sir Arthur Evans in 1894-1908. These investigations go to show that Crete, "a kind of half-way house between two continents," independently of the Eurasian and Eurafrican cultures, was the starting point of European civilization.

In the early Minoan culture (3400-2000 B.C.), contemporaneous with the early dynasties of Egypt, the excavations lie over Neolithic strata which go back to 9000 B.C. In the Middle Minoan Period (2000-1850 B.C.), corresponding with the twelfth Egyptian dynasty, polychrome decorations, fine faience, and painted sherds abound. The late Minoan Period (1850-1400 B.C.), corresponding with the Hyksos period and the New Empire in Egypt, is best represented by the palaces excavated at Knossos and Hagia Triada. The Knossian palace (the Cretan Labyrinth) is a stately, many-storied structure, with winding corridors, and subterranean passages, elaborate domestic arrangements and the best sanitation, including ingenious devices for ventilation, water-ways for drainage, cannon-shaped

terra-cotta piping, and latrines which, in construction, excel anything of the kind before the 19th century.

In the Aegean or Mycenaean culture revealed by Schliemann, there is the same skill in ceramics and sculpture, fresco-painting and ornamentation. Shaft-burial of the dead, in cysts sunk in rock, was succeeded by beehive tombs. The Mycenaean culture is probably synchronous with the Pelasgian.

The Hellenes of the mountains, the coast, the valleys, farms, and riversides had each a separate religion of their own, every little clan or village community worshiped its special god. Thus, Demeter was the special divinity of those who lived on farms and among cornfields, Dionysus of those who cultivated vineyards, Poseidon of those who dwelt by the sea, Pallas Athene of the Athenians. Artemis (Diana), Demeter (Ceres), Hermes (Mercury), Hera (Juno), Poseidon (Neptune), Dionysus (Bacchus) were, all of them, patron gods and goddesses of the healing art.

Pre-Hippocratic medicine was entirely prognostic and prophylactic. Prophylactic medicine was threefold: (1) Apotropaic, designed to avert disease by ritual sacrifice; (2) Hilastic, designed to abort disease by rites of propitiation or atonement; (3) Cathartic, designed to expel disease from the body by rites of lustration (purification). The ashes and rejects of sacrifice (katharmata) formed a kind of sacred pharmacopoeia, sometimes distributed among the worshipers and eaten by them, as

in the Asclepieia. Of the innumerable medicinal simples and animal remedies recommended by Galen, Dioscorides, and Pliny, it is obvious that but few have any pharmacologic rationale in the laboratory sense. The careful study of Max Höfler shows that the modern theory of animal remedies did not originate with the Greeks, but with the doctrine of signatures (Similia similibus).

The chief god of healing in the Greek Pantheon was Apollo. Legend relates that a knowledge of medicine was communicated by Apollo and his sister Artemis to the Centaur Chiron. Chiron was entrusted with the rearing and education of Aesculapius, the son of Apollo by the nymph Coronis. Aesculapius became proficient in the healing art. His followers made up an organized guild of physicians, the Asclepiads. The temples of his cult were the famous Asclepieia, of which the most celebrated were those at Cos, Epidaurus, Cnidus, and Pergamus. These temples became not unlike the health-resorts of modern times. The patients were received by the physician-priests, who stirred their imaginations by recounting the deeds of Aesculapius, the success of the temple treatment and the remedies employed. If the treatment was successful and the patient cured, he then presented a thank-offering to the god, usually a model of the diseased part in wax, silver, or gold, while a votive tablet giving the history of his case and its treatment was suspended in the temple. The details of symptoms and treatment were very meagre. The votive objects in the temples were merely indices of the

parts of the body affected, and seldom, if ever, represented the actual disease or deformity (Sudhoff).

Among the legendary children of Aesculapius, by his wife, Epione, were his daughters Hygieia and Panacea, who assisted in the temple rites. With the ancient Greeks, as with the Egyptians, Cretans, and Hindus, the serpent was venerated as the companion of many gods. Of the sons of Aesculapius, two, Machaon and Podalirius were the first military and naval surgeons.

The Tenth Iliad (lines 25-31) contains, Cardamatis thinks, a reference to autumnal malarial fevers. From specimens of the war-surgery of the Iliad it is plain that the surgeon's art was held in high esteem by the ancient Greeks, and that chieftains of high rank did not disdain to follow it.

Frölich counted 147 records of war wounds in the Iliad. There is no observation of disease, but Delpech thought the description of Thersites (second Iliad) a typical picture of rickets.

Greek medicine, as Osler has said, "had a triple relationship with science, with gymnastics, and with theology," and before the time of Hippocrates was regarded simply as a branch of philosophy.

Huxley regarded the growth of the Ionian philosophy in the 8th to 6th centuries B.C. as "only one of the several sporadic indications of some powerful mental ferment over the whole of the area comprised between

the Aegean and Northern Hindustan." This ferment, in the view of Zelia Nuttall and Elliot Smith, was the spread of a complex Eurasian and Eurafrican culture by the Phoenician navigators. It is significant that along the 35th parallel of North latitude we find, almost simultaneously in point of time, Zoroaster, Confucius, Buddha, Thales, and Pythagoras (Wright). The earliest of the Ionian philosophers was Thales of Miletus (639-544 B.C.). Empedocles (504-443 B.C.), introduced into philosophy the doctrine of the elements, earth, air, fire, water, as "the four-fold root of all things."

Empedocles is said to have raised Pantheia from a trance, to have checked an epidemic of malarial fever by draining swampy lands and to have improved the climatic condition of his native town by blocking a cleft in a mountain side.

Pythagoras (580-489 B.C.) discovered the pons asinorum. He was the first to investigate the mathematical physics of sound.

The Chaldean number-lore of Pythagoras exerted a profound influence upon the Hippocratic doctrine of crises and critical days. Long before Aristotle, probably before Hippocrates, it was held that, corresponding to the four elements of Empedocles, fire, air, water, earth, and the four qualities, hot, cold, moist, dry, are the four humours of the body, viz., blood, phlegm, yellow bile, and black bile. The doctrine of the four humours was a vague foreshadowing of the endocrine and general biochemi-

cal aspects of human physiology.

In Egypt, Pythagoras learned the doctrine of transmigration of souls or metempsychosis. After Pythagoras, the most important of the Greek Philosophers, with the exception of Plato and Aristotle, was his pupil, the almost mythical Alcmaeon of Crotona (circa 500 B.C.), who anticipated Empedocles in the doctrine that health is the equipoise (isonomia), disease, the preponderance (monarchia) of heat, cold, moisture, dryness, acidity, sweetness, etc. Democritus of Abdera (460-360 B.C.) first stated the atomic theory.

Among the Spartans, the surgeons were held in the same high regard as among the Homeric heroes. Among the Attic or Ionian Greeks, the medical profession, as we approach the Age of Pericles, is found to be more highly specialized. Practitioners began to receive stipulated fees for their services, city and district (public) physicians came to be appointed at an annual salary. These public physicians existed from Homer's time, are mentioned by Herodotus and Diodorus, and were well-known in Athens from the Periclean Age down to the 1st century A.D. There were also military and naval surgeons among the Athenians, as among the Spartans. There were again midwives, professional lithotomists, druggists and veterinarians. Medical instruction was not organized and was in effect private.

Such human anatomy as the Greek physicians and surgeons learned was identical with the sculptor's knowledge of the subject. What Pater calls "the age of athletic prizemen" was also the great age of Greek

sculpture, and in nothing is the discriminating power of Greek intelligence more beautifully and nobly shown than in the masterpieces of the great artists of this period.

II. The Classic Period (460-136 B. C.)

European medicine begins properly in the Age of Pericles and its scientific advancement centres in the figure of Hippocrates (460-370 B. C.). A contemporary of Sophocles and Euripides, Aristophanes and Pindar, Socrates and Plato, Herodotus and Thucydides, Phidias and Polygnotus, he lived at a time when the Athenian democracy had attained its highest point of development. Hippocrates was born on the island of Cos, at the beginning of the eightieth Olympiad, of an Asclepiad family. To him medicine owes the art of clinical inspection and observation. The central Hippocratic doctrine, the humoral pathology, which, as we have seen attributes all disease to disorders of the fluids of the body, has, in its original form, long since been discarded, although some phases of it still survive in the modern theory of serodiagnosis and serotherapy. It is the method of Hippocrates - his use of the mind and senses as diagnostic instruments, together with his transparent honesty and his elevated conception of the dignity of the physicians's calling, his high seriousness and deep respect for his patients - that makes him, by common consent, the "Father of Medicine" and the greatest of all physicians.

Of 42 clinical cases in Hippocrates - almost the only records of the kind for the next 1700 years - 25 (60 per cent.) are reported, with characteristic sincerity, as fatal.

In the view of classical philologists, Hippocrates is "a name without writings." The works attributed to the Hippocratic school are, in fact, a Canon or scriptural body of doctrine and, as Jones infers, probably the remains of the library of the school at Cos. The greater treatises now usually regarded as genuine are: Epidemic Diseases, I-III; Regimen in Acute Diseases; Airs, Waters, and Places; Fractures; Joints (Dislocations) and Wounds of the Head. The Oath, the earliest and most impressive document in medical ethics, is not usually regarded as a genuine Hippocratic writing. Yet both the Oath and Law are so much in keeping with the ethical spirit of the great Coan that they are usually included in the Hippocratic Canon. The dignity of the Greek physician was based more upon his supposed ability to predict clinical and epidemiological happenings than upon his power to control them. To this end Hippocrates instituted, for the first time, a careful, systematic, and thorough-going examination of the patient's condition, including the facial appearance, pulse, temperature, respiration, excreta, sputum, localized pains, and movements of the body. The treatise on Nutrition (Peritrophes, circa 400 B.C.) contains the first mention of the pulse in Greek medicine and of the peculiar theory of the circulation

(arteries from the heart, veins from the liver) which persisted up to the time of Harvey (Singer).

While there is much in the surgical writings of Hippocrates that is faulty, incomplete, or not in accordance with modern practice, they are the only thing of value on the subject before the time of Celsus. Hippocrates was the first to notice that gibbous spine (Pott's disease) often coexists with tubercle of the lungs. In Wounds he says that they should never be irrigated except with clean water or wine, the dry state being nearest to the healthy, the wet to the diseased. Hippocrates recognized that "rest and immobilization are of capital importance." In clinical diagnosis, he was the first to note the "succussion sound." In therapeutics, he believed simply in assisting nature.

Thus, the Hippocratic or Coan School aimed at prognosis by means of a general semeiology of known diseases, with very generalized therapy. The patient was the real thing, the disease not an entity but a fluctuating condition of the patient's body, a battle between the materies morbi and the natural self-healing tendency (physis) of the body. The Cnidian School, on the other hand, centred on the disease rather than the patient.

The Law, the Oath, and the opening chapters of the discourse On the Sacred Disease are the loftiest utterances of Greek medicine and, whether due to Hippocrates or not, they are informed with the spirit of his ethical teaching. Behind the sensible phenomena of nature he surmised

the existence of some tremendous power (enormon), which sets things going.

Hippocrates voiced the spirit of an entire epoch, and after his time there was a great gap in the continuity of Greek medicine. In succeeding centuries, the open-minded, receptive spirit of his teaching became merged into the case-hardened formalism of dogmatists like Praxagoras.

The greatest scientific name after Hippocrates is that of "the master of those who know," the Asclepiad Aristotle (384-322 B.C.) of Stagira, who gave to medicine the beginnings of botany, zoölogy, comparative anatomy, embryology, teratology and physiology, and the use of formal logic as an instrument of precision. He taught anatomy by the dissection of animals, and by the use of "anatomical diagrams" ("paradigms, diagraphs, schemata") which were "represented on the walls of his Lyceum." He was, in fact, the greatest biologist, not only of antiquity, but for the 2000 or more years preceding the advent of such men as Linnaeus or Cuvier.

Aristotle is at his weakest in physics and physiology, in which he is mainly speculative. He named the aorta, and announced the doctrine of the primacy of the heart. His criterion of living things was the possession of soul (psyche), vegetative in plants, sensitive in animals, rational in man.

Aristotle left his library and botanic garden to his friend and

pupil, Theophrastus of Eresos (370-286 B.C.), who was also a physician, and was called the "protobotanist" because he did for the vegetable kingdom what Hippocrates had previously done for surgery and clinical medicine.

With the founding of Alexandria (331 B.C.), Greek science and culture were firmly implanted in the ancient civilization of Egypt.

Our knowledge of the two great Alexandrian antomists, Herophilus and Erasistratus (4th century B.C.), the originators of dissecting, is not based upon any textual record of their writings, but was pieced together out of Galen. Herophilus was, in Sudhoff's phrase, the Father of Scientific Anatomy. Erasistratus was the first experimental physiologist.

In the 3rd century B.C., Alexandrian medicine was introduced into Mesopotamia, and in this way Syria acquired the main body of Hippocratic doctrine _via_ Egypt. Syria became the stepping-stone or first station between Oriental, Graeco-Alexandrian and mediaeval medicine.

The tendencies of the school of Empirics, which sprang from the Alexandrian school in the 2nd century before Christ, culminated in an actual development of quasi-experimental pharmacology and toxicology. Mithridates, King of Pontus (120-63 B.C.), achieved a reputation in the art of giving and taking poisons. He is said to have immunized himself against poisoning by means of the blood of ducks fed upon toxic principles.

III. The Graeco-Roman Period (156 B.C. - 576 A.D.)

After the destruction of Corinth (146 B.C.), Greek medicine may be said to have migrated to Rome. Apart from the writings of a private littérateur like Celsus, the principal Roman contribution to medicine was the splendid sanitary engineering of architects like Vitruvius. The most eminent physicians in Rome came from Asia Minor, from the Schools of Pergamus, Ephesus, Tralles and Miletus (Wellmann). Greek medicine was finally established on a respectable footing in Rome through the personality, tact, and superior ability of Asclepiades of Bithynia (124 B.C.). He was the first to mention tracheotomy. His influence for good was that of a superior personality but died with him. His pupils and adherents, Themison and others, exaggerated his doctrines into a formal "Methodism," while the followers of the Stoic philosophers endeavoured to found a system of medicine based upon the physical action and status of the vital air or <u>pneuma</u>. The Hellenic Renaissance in Rome was thus characterized by three different ways of looking at disease as disturbances of the liquid, solid, or gaseous constitutents of the body, viz., Humoralism, Solidism, and Pneumatism. In all this welter of theorizing, six names stand out above the rest - Celsus, Dioscorides, Rufus, Soranus, Galen and Antyllus.

Although Roman medicine was almost entirely in Greek hands, the best account of it we have goes by the name of Aurelius Cornelius Celsus.

Celsus was ignored by the Roman practitioners of his day; but with the Revival of Learning he had his revenge, in that his work (De re medicina) was one of the first medical books to be printed (1478). He was the first to recommend nutritive enemata. The seventh book of De re medicina is surgical, and contains one of the first accounts of the use of the ligature, and a classic description of lateral lithotomy. Under the Romans, surgery (including obstetrics and ophthalmology) attained a degree of perfection which it was not to reach again before the time of Ambroise Paré. Over two hundred different surgical instruments were found at Pompeii. Celsus is also very effective on the different malarial fevers of Italy and their treatment, on gout, and on the treatment of different kinds of insanity. He was the first important writer on medical history.

Heliodorus, who antedated Celsus, gave the first account of ligation and torsion of blood-vessels, and was one of the first to treat stricture by internal urethrotomy. Antyllus, long before Daviel, mentions the removal of cataract by extraction and suction, but his name and fame are permanently associated with his well-known method of treating aneurysms by applying two ligatures and cutting down between them, which held the field until the time of John Hunter.

Pedacius Dioscorides, the originator of the materia medica, was a Greek army surgeon in the service of Nero (54-68 A.D.), and utilized his

opportunities of travel in the study of plants. His work is the authoritative source on the materia medica of antiquity. Up to the beginning of the 17th century the best books on medical botany were virtual commentaries on the treatise of Dioscorides, the historic source of most of our herbal therapy, even of the famous mediaeval substitutes for anaesthesia. Mandragora wine (oinos mandragorites) is prescribed internally by Dioscorides as a draught for insomnia or pain.

Aretaeus the Cappadocian, who also lived either under Domitian or Hadrian (2nd to 3rd century A.D.) comes nearer than any other Greek to the spirit and method of Hippocrates. As a clinician, Aretaeus ranks next to the Father of Medicine in the graphic accuracy and fidelity of his pictures of disease, of which he has given the classic accounts of pneumonia, pleurisy with empyema, diabetes, tetanus, elephantiasis, diphtheria (ulcera Syriaca), and the aura in epilepsy.

Another great eclectic was Rufus of Ephesus, who lived in the reign of Trajan (98-117 A.D.), and whose literary remains and fragments have been preserved in the Paris text of 1554, and the bilingual of Daremberg (Paris, 1879).

Soranus of Ephesus of the 2nd century A.D., a follower of the Methedist school of Ascelpiades, is our leading authority on the gynaecology, obstetrics, and pediatrics of antiquity. After Soranus, there were no real additions to obstetrics before the time of Paré, some 1500 years

later. The pediatric section in Soranus is the finest contribution to the subject in antiquity, containing the most rational precepts as to infant hygiene and nutrition, and a recognizable account of rickets.

The Natural History of Pliny the Elder (23-79 A.D.), of which Books XX-XXXII deal exclusively with medicine, is a vast compilation of all that was known in his time of geography, meteorology, anthropology, botany, zoölogy, and mineralogy.

The ancient period closes with the name of the greatest Greek physician after Hippocrates, Galen (131-201 A.D.), the founder of experimental physiology. Compared with Hippocrates, Galen seems like the versatile, many-sided man of talent as contrasted with the man of true genius. He was the most skilled practitioner of his time, but left no good accounts of clinical cases, only miraculous cures. Up to the time of Vesalius, European medicine was one vast <u>argumentum ad hominem</u> in which everything relating to anatomy and physiology, as well as disease, was referred back to Galen as a final authority, from whom there could be no appeal. After his death, European medicine remained at a dead level for nearly fourteen centuries.

Galen was the most voluminous of all the ancient writers, and the greatest of the theorists and systematists. His works are a gigantic encyclopaedia of the knowledge of his time. He differentiated pneumonia from pleurisy, was the first to mention aneurysm, described the

different forms of phthisis, mentioning its infectious nature and proposing a full milk diet and climatotherapy (sea voyages and dry elevated places) for treatment. He even paid two special visits to the isle of Lemnos in order to investigate the therapeutic value of its sacred sealed earth (terra sigillata).

Galen's neurology is the best feature of his anatomical work. He was the first and foremost contributor to experimental physiology before Harvey. He was the first to describe the cranial nerves and sympathetic system, and gave the first valid explanation of the mechanism of respiration. He fully deserves the enconium of Guy de Chauliac, that he was "greatest in experimental demonstration." But Galen, as Neuburger puts it, made his whole physiological theory "a skilful and well-instructed special pleading for the cause of design in nature".

There are three Galenic superstitions which have had a great deal to do with preventing the advancement of medical science. First, the doctrine of Vitalism, which maintained that the blood is endued with "natural spirits" in the liver, with "vital spirits" in the left ventricle of the heart, and that the vital spirits are converted into "animal spirits" in the brain, the whole organism being animated by a "pneuma." Second, the notion that the blood in its transit through the body, passes from right to left ventricle by means of certain imaginary invisible pores. Third, the idea that "coction" or suppuration is an essential

part of the healing of wounds led to those Arabist notions of "healing by second intention," setons and laudable pus, which, although combated by Mondeville, Paracelsus and Paré, were not entirely overthrown before the advent of Lister.

Rome was ever a hard, cold-blooded task-mistress, with a callous policy of "duties without rights" for the army and the people, who were governed by force, fear, hunger, impoverishment, and worked to the stage of exhaustion which destroys inventive genius. Even after Asclepiades, Galen and Soranus had made the status of medicine respectable, the Roman Quirites continued to regard the profession as beneath them. Under Augustus Caesar, however, physicians acquired the equestrian dignity of the knightly class (equites), and the army had a well-organized medical corps. In arrangement and appointments, the military hospitals excavated at Novaesium, near Bonn (1887-1901) and Carnuntum, on the Danube (1904), both of the 1st century A.D., surpass anything else of the kind in antiquity.

A very dubious and much satirized class were the eye specialists or oculists (medici ocularii) who, each of them, sold a special eye-salve stamped with his own private seal, usually compounded of salts of zinc and other metals.

A special feature of Roman medicine was the cultivation of warm public baths (thermae) and of mineral springs.

The Etruscans were wonderfully skilled in dentistry. Martial

mentions false teeth. Some remarkable specimens of Etruscan bridge-work are preserved in the museum of Corneto and have been described by Guerini and Walsh.

The special talent of the Romans was for military science, and the making and administration of laws. Their hygienic achievements, such as cremation, town-planning, the sensible, well-ventilated houses, central heating, the paved streets and macadamized roads, the great aqueducts, sewers, drains and public baths, the solicitude for pure food as part of the cult of Vesta and Juturna, were of far greater consequence than their native literary contributions to medicine.

THE BYZANTINE PERIOD (476-732 A. D.)

The downfall of the Western Empire was mainly due to the degeneration of the Roman stock. Some think that the malarial fevers which had begun to devastate the Italian peninsula had as much to do with weakening their fiber as the luxuries and dissipations to which they were continually exposed. Degeneration of mind and body, with consequent relaxation of morals, led to mysticism and that respect for the authority of magic and the supernatural which was to pave the way for the bigotry, dogmatism, and mental inertia of the Middle Ages.

Through the conflict of Pagan and Christian modes of thought, almost all of the intellectual energy of the period was dissipated in religious controversy, while medicine had become an affair of salves and poultices, talismans and pentagrams, with a mumbling of incantations and spells very like the backwood pranks of Tom Sawyer and Huckleberry Finn, or some of the vagaries of Christian Science. "The chief monuments of learning were stored in Byzantium until Western Europe was fit to take care of them."

Although the Byzantine power lasted over a thousand years (395-1453 A. D.), medical history is concerned chiefly with the names of four industrious compilers who were prominent physicians in the first

three centuries of its existence. Oribasius (325-403 A.D.), is chiefly remarkable as a torch-bearer of knowledge rather than as an original writer. Aëtius of Amida, who lived in the 6th century A. D., was a royal physician. He left an extensive compilation, usually called the Tetrabiblion. He gives a description of epidemic diphtheria not unlike that of Aretaeus, mentioning paralysis of the palate as a sequel, and his work contains the best account of diseases of the eye, ear, nose, throat, and teeth in the literature of antiquity. He has also interesting chapters on goiter and hydrophobia. Aëtius supplies many lost passages in Oribasius, and describes modes of procedure (tonsillotomy, urethrotomy, treatment of haemorrhoids) not found elsewhere. To him is due the first description of ligation of the brachial artery above the sac for aneurysm.

Alexander of Tralles (525-605), a much travelled practitioner who finally settled in Rome, was the only one of the Byzantine compilers who displayed any special originality. His accounts of insanity, gout, and the dysenteric and choleraic disorders are above the average. He has a highly original chapter on intestinal worms and vermifuges, is said to have been the first to mention rhubarb, and first recommended colchicum (hermodactyl) in gout. Like Galen, he recommends a full milk diet, change of air, and sea voyages for phthisis.

Paul of Aegina (625-690), the last of the Greek eclectics and compilers, was the author of an Epitome of medicine in seven books. Although Paul was a physician of high repute, we may judge how low medicine

had sunk in the 7th century by his apologetic statements as to lack of originality on his part. He was, however, a very capable surgeon.

During the Byzantine period, an interesting contribution to clinical medicine was made by the Fathers of the Christian Church, namely, the description of the earlier epidemics of smallpox and diphtheria.

Eusebius described a Syrian epidemic in 302 A.D. Another was described by Gregory of Tours in 581, and the term "variola" was first employed by Marius, Bishop of Avenches, in 570.

THE MOHAMMEDAN AND JEWISH PERIODS

(732-1096 A. D.)

While the principal service of Islam to medicine was the preservation of Greek culture, ~~xxx~~ the Saracens themselves were the originators not only of algebra, chemistry, geology, but of many of the so-called improvements or refinements of civilization. In the intellectual sphere, the monotheism and the dialectic tendencies of Galen and Aristotle appealed strongly to the Mohammedans. The general trend of Oriental religous fatalism was toward contemplative brooding and resigned submission to authority. We call the medical authors of the Mohammedan period "Arabic" on account of the language in which they wrote, but, in reality, most of them were Persian or Spanish born, and many of them were Jewish.

The Nestorian heretics gained control of the school of Edessa in Mesopotamia with its two large hospitals, and made it a remarkable institution for teaching medicine, but were driven out by the orthodox Bishop Cyrus in 489. Fleeing to Persia, where their theologic notions were not opposed, they established the famous school at Gondisapor, which was the true starting-point of Mohammedan medicine.

The earlier centuries of the Mohammedan period were occupied in translating the works of Hippocrates, Galen, Dioscorides, and other Greek classics into Arabic. The principal Arabic translators in the 8th and

9th centuries were Johannes Mesuë the elder (777-837), and the Nestorian teacher Honain ben Isaac or Johannitius (809-873). Johannitius was in his day the leading medical spirit of Bagdad.

Rhazes (860-932), a great clinician, ranks with Hippocrates, Aretaeus, and Sydenham as one of the original portrayers of disease. His description of smallpox and measles is the first authentic account in literature. His great encyclopaedia of medicine, the El Hawi or Continens, made up of an enormous mass of extracts from many sources, together with original clinical histories and experiments in therapeutics, reveals Rhazes as a Galenist in theory, but a true follower of Hippocrates in the simplicity of his practice. The Brescia editio princeps of 1486 is incidentally the largest and heaviest of all the incunabula.

Haly ben Abbas, a Persian mage who died in 994, was the author of the Almaleki (Liber regius or "Royal Book").

Ibn Sina or Avicenna (980-1037), court physician and vizier to different caliphs was physician in chief to the celebrated hospital at Bagdad. His wonderful description of the origin of mountains (cited by Draper and Withington) fully entitles him to be called the "Father of Geology." Avicenna is said to have been the first to describe the preparation and properties of sulphuric acid and alcohol. His recommendation of wine as the best dressing for wounds was very popular in mediaeval practice. Avicenna also described the guinea worm; anthrax as

"Persian fire", gave a good account of diabetes, and is said to have noticed the sweetish taste of diabetic urine.

Useibia (1203-69), of Damascus, the first historian of Arabic medicine, wrote a series of biographies of ancient physicians.

Other prominent medical figures of the Eastern Caliphate were the Jewish physician and neo-Platonist philosopher, Isaac Israeli (ben Solomon), of Kaironan, called Isaac Judaeus (855-955), who wrote a book on uroscopy and a treatise upon dietetics; and the Arabian traveller Abdollatif (1161-1231), who had opportunities for studying human skeletons which convinced him that Galen's osteology must be wrong.

The Western or Cordovan Caliphate (655-1236) attained highest prosperity under the Spanish or Ommiade dynasty (755-1036). Its leading medical authors were the clinician Avenzoar, the surgeon Albucasis, and the physician-philosophers Averroës and Moses Maimonides.

Albucasis (1013-1106) was author of a great medico-chirurgical treatise called the Altasrif (or "Collection"), which contains illustrations of surgical and dental instruments. He was apparently the first to write on the treatment of deformities of the mouth and dental arches, and he mentions the obstetric posture which is now known as the "Walcher position".

The greatest of the Moslem physicians of the Western Caliphate was the Cordovan Avenzoar, who died at Seville in 1162. He was one of the

few men of his time who had courage to tilt against Galenism, and by his description of the itch-mite (Acarus scabiei) he may be accounted the first parasitologist after Alexander of Tralles.

Averroës, also Cordovan-born (1126-1198), and a Spanish Moslem, was more noted as a philosopher and free thinker than as a physician. His Kitab-al-Kullyat transliterated as Colliget (book of Universals), was an attempt to found a system of medicine upon the customary neo-Platonic modification of Aristotle's philosophy.

Moses Maimonides (1135-1204), was court-physician to Saladin. His treatise on personal hygiene (Tractatus de Regimine Sanitatis) was written for Saladin's private use.

Such able chemists as the Arabians could not fail of being good pharmacologists. The Grabadin, or apothecary's manual (Antidotarium), of the eponymous or pseudonymous Mesue junior, now called "pseudo-Mesue," was the most popular compendium of drugs in mediaeval Europe. The Mesue treatise on purgatives divides the latter into laxative (tamarinds, figs, prunes, cassia), mild (wormwood, senna, aloes, rhubarb) and drastic (jalap, scammony, colocynth). The popular drug-list attributed to Serapion junior was translated into Latin. The most important Persian work on pharmacology is the materia medica (circa 970) of Abu Mansur.

The Arabians derived their knowledge of Greek medicine from the Nestorian monks, many practical details from the Jews, and their astrologic lore from Egypt and the far East. In the past, the Arabian

physician, whose professional importance was gauged by the height of his turban and the richness and length of his sleeves, was usually an astrologer and a magician, and resorted to all manner of sensational trade-tricks and surprises in order to impose his authority. He abstained from dissecting out of religious conviction.

The largest and best appointed of the Mohammedan hospitals were those founded at Damascus (1160) and Cairo (1276). The Cordovan Caliphate was equally well off in the number, if not the extent, of its hospitals. The Arabians were far ahead of their European contemporaries in kindly treatment of the insane.

Arabian medicine was the parent of alchemy, the founder of which was Jabu or Geber (702-765), the discoverer of nitric acid and aqua regia and the describer of distillation, filtration, sublimation, water-baths, and other essentials of chemical procedure. Alchemy was combined with astrology. Geber's parable of a medicine, which could heal any of six lepers, was regarded by Boerhaave as nothing more than an allegory of the philosopher's stone for transmuting the six baser planetary metals into gold. Hand in hand with this idea of transmutation of metals went the notion of a polyvalent "elixir of life," which was supposed to be of the nature of a "potable gold". The search for potable gold led to the discovery of aqua regia and the strong acids by Geber and Rhazes.

From their constant contact with strange lands and peoples, the Arabian pharmacists or "sandalani" were the exploiters if not the

introducers of a vast number of new drugs. The possibilities of anaesthesia by inhalation were known to the Arabians, as well as to Dioscorides and the mediaeval surgeons, and presumably the original knowledge came from India.

The Hebrew and Mohammedan physicians, with their peculiar analytic cast of mind, their intensive modes of thought and their appreciation of "values," soon acquired a materialistic way of looking at concrete things. Thus, while medical men under Christianity were still trifling with charms, amulets, saintly relics, the Cabala, and other superstitions, Jewish and Mohammedan physicians were beginning to look upon these things with a certain secret contempt.

During the Middle Ages and long after, the lot of the Jewish physician in Europe was to be used and abused. In the 10th and 11th centuries, he was, as Billings says, "a sort of contraband luxury," resorted to and protected by prince and prelate alike, on account of his superior scientific knowledge, but hardly countenanced for any other reason. The School of Salerno utilized them as teachers, until it had developed enough home-grown talent to get along without them.

THE MEDIAEVAL PERIOD (1096-1438)

The Middle Ages, the period of feudalism and ecclesiasticism, are commonly decried for servile obeisance to authority, with its attending evils of bigotry, pedantry, and cruelty. The Crusades aroused the feeling of nationhood. The organization of citizens against the robber barons awakened civic consciousness. In the great struggle between collectivism and individualism which began from that hour, intellectual dependence was bound to go to the wall if it came into conflict with Church or State. Only idle bigotry could affirm that Pope and Emperor did not do a great deal for medicine in the advancement of good medical legislation, in the chartering and upbuilding of the mediaeval universities, in the great hospital movement of the Middle Ages. The mediaeval thinkers were all under the ban of authority. The natural histories of Pliny and the Physics of Aristotle were accepted by the authorities as beyond cavil.

The medicine of the Middle Ages fell under the bondage of words, mistook the symbol for the thing, was forward in mechanical inventions, in military surgery and public sanitation, but decidly backward in anatomy, physiology, pathology, and internal medicine.

The general practice of surgery, including most of the major operations, was relegated to barbers, bath-keepers, sowgelders, and wayfaring

mountebanks. The heresy imposed by the Arabist commentators of Galen, that "coction" (suppuration) and "laudable pus" were essential to the healing of wounds, made operative surgery a perilous and meddlesome undertaking.

The history of mediaeval medicine is mainly the history of the Latinization and subsequent Arabization of the West. Neuburger divides it into four periods, viz., the Monastic or Latinizing period (5th-10th centuries); the Salernitan (11th-12th centuries); the temporary enlightenment of the 13th century, in which the Arabist culture was grafted upon that of the West; and the pre-Renaissance period (14th century), in which this culture was dominant.

With the downfall of Rome came the Dark Ages during which Western Europe passed into a tedious period of material waste and intellectual decadence.

The transition was not catastrophic, but gradual. The Germanic conquest entailed the loss of thousands of lives, the devastation of great tracts of country, the desolation of many cities, and the destruction of innumerable landmarks of art and culture. Science and learning sought refu in the bosom of the Church, and no less than Cassiodorus, "the last of the Romans," pointed the way (Neuburger).

Thus began the period of Monastic medicine, in which there grew up a cult of faith-healing or theurgic therapy. Western medicine, unlike that of Byzantium and Islam, went into eclipse. Science and culture

went to the wall, the schools of secular learning crumbled and disappeared, religious zeal and fanatical asceticism became the order of the day. "The Benedictines became the Nestorians of the West." In the same year in which Justinian closed the School of Philosophy at Athens (529), St. Benedict of Nursia (480-544) founded, on the site of an ancient temple of Apollo, the cloister of the Benedictine order at Monte Cassino, in the Campagna. Under the Visigoths in Spain (507-711), the activities of the medical profession were crushed by a Draconic code of laws. With the conversion of the Visigoths to Christianity (586), monastic medicine took its usual course. Cloisters and church foundations even had their own physicians.

Under the Merovingian monarchs (<u>les rois fainéants</u>) in France (486-741), Latin influences prevailed, but the dynasty has little to its credit save a string of bloody civil wars, and physicians had a hard time of it. Gregory of Tours (538-593) records that the Frankish physicians had some skill in surgery and were sometimes in request as forensic experts in trials, but even those in attendance on royalty were humiliated or put to death if they failed to cure. The people were given over to a belief in wonder-cures by strolling surgeons, to holy relics and exorcism. In time of epidemics, they came in great crowds to pass nightly vigils in the churches, an analogue of the temple-sleep. With the advent of Charlemagne (768-814) as Emperor of the West (800), medicine came into better times. The cultural soil was prepared by the wandering Irish and Anglo-Saxon monks. Charlemagne

had a physic-garden. From the Ecclesiastical History of the Venerable Bede (674-735), we gather that medicine was not neglected by English monks.

The encyclopaedia <u>Physica</u> of the Abbot of Fulda and Archbishop of Mainz, Hrabanus Maurus (776-856), Alcuin's favourite pupil and the <u>primus praeceptor Germaniae</u>, treats of medicine in the 6th, 7th, and 18th books and gives a German-Latin glossary of anatomic terms. Anglo-Saxon literature took its start in the reign of Alfred the Great (871-901), and held its own until the middle of the 12th century. The principal medical writings of the period are the <u>Leech-Book</u> of Bald, the <u>Lacnunga</u>, a book of Anglo-Celtic magic and translations of Apuleius and Sextus Placitus. In lower Italy, Sabbatai ben Abraham, called Donnolo (913-965) was a famous practitioner and his <u>Antidotarium</u> is the oldest known Hebrew medical work written in Europe.

Medicine in the 11th and 12th centuries was lifted to a much higher level by the School of Salerno. That it was an ecclesiastical foundation is regarded by most historians as an agreeable <u>fable convenue</u>, for the whole character of the school was that of an isolated laical institution. Its anatomy was based upon that of swine, its physiology and pathology were Galenic, its diagnosis mainly pulse- and urine-lore, but diseases were studied first-hand, in a straightforward, spontaneous, engaging manner, therapy was rational, with an effective scheme of dietetics,

Salernitan surgery was new and original, obstetrics and nursing were cultivated by talented women. From Magna Graecia, Byzantium, and Toledo came the three main streams of Greek culture which went to the formation of the Hellenic tradition. Other contributory influences were the Monastic, the Jewish and the Arabic. Thus the legend that the School of Salerno was founded by "Four Masters," a Greek, a Latin, a Jew and a Saracen, may symbolise the four cultural influences which went to its making.

Arabic medical doctrine was introduced at Salerno and fastened upon Western European culture until the 17th century by Constantinus Africanus (circa 1020-1087). The most remarkable contribution of the Salernitan school to internal medicine is the Tractatus de aegritudinum curatione, the first example of an encyclopaedic text-book of medicine. Many Salernitan productions are contained in the "Breslau Codex".

The Antidotarium of Nicolaus Salernitanus was the first formulary and one of the first medical books to be printed. It contains many new Eastern drugs, also the original formula for the "anaesthetic sponge."

Gilles de Corbeil (Aegridius Corboliensis), Canon of Paris and physician to Philippe Auguste of France (1165-1213), wrote two poems on the pulse and the urine. He lamented the decline of Salerno after it had been sacked by Henry VI (1194). In the 13th century, the medical authority of Salerno was gradually impinged upon by the great rival schools of Naples, Palermo, and Montpellier, and the great school was finally abolished

by Napoleon on November 29, 1811.

The Physica of St. Hildegard (1099-1179), describes the healing powers of the known plants, minerals and animals.

The principal outcome of the School of Salerno was the work of two surgeons, Roger (Ruggiero Frugardi) of Palermo and Roland (Rolando Capelluti) of Parma, whose writings were independent of the influence of Constantinus Africanus or other Arabist sources (Gurlt). Roger's Practica, re-edited by his pupil Roland about 1230-40 (Sudhoff) and commented upon by the "Four Masters" a little later, was never separately printed. Roger's work became a standard text-book at Salerno.

Roger, Roland, and the Four Masters were succeeded by the 12th century surgeon Jamerius, by Hugh of Lucca, by Bruno of Longoburg, an advocate of dry (aseptic) wound treatment, and by Hugh's son or disciple, Teodorico Borgognoni (1205-1296), or Theodoric. Theodoric contradicted the pseudo-Galenist dogma of coction, laudable pus, or healing by second intention, and stood out in his day as a sturdy pioneer of a simple, expectant, dry treatment (rational asepsis). Only Mondeville and Paracelsus upheld these principles before Lord Lister and von Bergmann.

Surgical sleeping draughts are mentioned by the Church Fathers St. Hilary of Poiters (De trinitate, x, 14) and Origen. Salernitan reference to the "soporific sponge" occurs as an interpolation in the beautiful Jensen Antidotarium of Nicholas of Salerno. The sponge was

steeped in a mixture of opium, hyoscyamus, mulberry juice, lettuce, hemlock, mandragora and ivy, dried and, when moistened, "inhaled" (probably swallowed) by the patient, who was subsequently awakened by applying fennel-juice to the nostrils. The recipe was usually that of the old Dioscoridean sleeping potion. Through the Middle Ages, mandragora was the soporific *par excellence*.

The ablest Italian surgeon of the 13th century was Guglielmo Salicetti, called Saliceto. He did not separate surgical diagnosis from internal medicine, and kept a good record of case histories. Book IV of his treatise contains the first known treatise on regional or surgical anatomy (Sudhoff). He was the first after Roger to assign venereal contagion (*coitus cum foeda meretrice*) as the real cause of chancre, bubo, and phagedenic ulcers. In his treatise on practice, Saliceto left a classic description of dropsy due to contracted kidney. The sound principles of Saliceto were ably upheld by his pupil, Lanfranchi of Milan. Unlike Saliceto, Lanfranc was a cauterist and averse to the knife.

Contemporary with Lanfranc was his loyal follower, Henri de Mondeville (1260-1320), who made a valiant last stand for the principle of avoiding suppuration by simple cleanliness. In opposition to the salve-surgery of the Galenists, Mondeville advises simply to wash the wound clean and put nothing whatever into it, since "wounds dry much better before suppuration than after it." Wine and other "wound-drinks" were given to strengthen the patient, in opposition to the routine practice of

cutting down his diet. For haemorrhage Henri recommends styptics, digital compression, acupressure, and torsion of the isolated vessel by means of a sliding-noose ligature.

A man of far different type was Guy de Chauliac (1300-68), the most eminent authority on surgery in the 14th and 15th centuries. He was a writer of rare learning, endowed with a fine critical and historic sense. Guy believed in cutting out cancer at an early stage with the knife. He suspended fractures in a sling bandage, or (if in the thigh) by means of weight and pulley. Guy de Chauliac was on the whole a reactionary in the important matter of the treatment of wounds, and threw back the progress of surgery for some six centuries by giving his personal weight to the doctrine that the healing of a wound must be accomplished by the surgeon's interference - salves, plasters and other meddling - rather than by the healing power of nature. His most important work is the Inventarium et Collectorium (Chirurgia magna), written in 1363, and first published in French translation at Lyons in 1478.

Guy's most distinguished pupil was Pietro d'Argelata (died 1423). D'Argelata taught the dry treatment of wounds, but powdered them; was skilled in dentistry, used sutures and drainage-tubes in wounds, trephined the skull, incised the linea alba in postmortem Caesarean section, and sometimes operated for hernia, stone, and fistula in ano. The latter operation attained a high degree of perfection in the hands of John of Arderne (1306-90[?]), the earliest of the English surgeons. Arderne wrote

treatises on passio iliaca (appendicitis or intestinal obstruction) and gout; and an essay on clysters (1370). He employed irrigation in renal and intestinal colic, cystitis, and gonorrhea.

The Flemish surgeon Jean Yperman (1295-1351), whose Chirurgie was printed from the Flemish manuscript by Carolus (Ghent 1854), was a pupil of Lanfranc. He gives good accounts of trephining, arrow-wounds, healing of harelip, and enlargement of the opening in reposition of prolapsed viscera. The chapter on leprosy stresses the anaesthesia, and the possibility of infection by sexual intercourse. Of the Royal Touch for scrofula, he slyly notes that curable cases will get well without it (Neuburger).

Hand in hand with the mediaeval development of surgery, there necessarily went some effort to improve the status of human anatomy. Dissecting, at first rigorously proscribed by law and sentiment, became more and more a matter of course. Payne has divided mediaeval anatomic teaching into three periods: First, the Salernitan (800-1200), in which instruction was based upon the dissection of animals as set forth in the Anatomia Porci of Copho; second, the Arabist period (13th century), in which such dissections were superseded by books and lectures.

The interest of the third period centres in the revival of human dissecting by Mondino de Luzzi (circa 1275-90), called Mundinus of Bologna.

The first recorded postmortem was conducted on a case of suspected poisoning by Bartolomeo da Varignana at Bologna in 1302. Public dis-

sections were decreed at the University of Montpellier in 1366.

In the 13th century the Arabist culture was securely grafted upon European medicine by means of Latin translations, and internal medicine in this period had strong scholastic leanings. Its votaries were men of the type of the foremost intellectual leaders of the 13th century, such as Roger Bacon or Albertus Magnus. We call the mediaeval writers on practice of medicine "Arabists" on account of their unswerving fidelity to Galenic dogma as transmuted through Mohammedan sources.

Gerard of Cremona (1114-87), who came from Italy to Toledo to learn Arabic and remained there all his life, was the principal interpreter of this Toledan treasure hoard. He translated Rhazes, Serapion, Isaac Judaeus, Albucasis, and the Canon of Avicenna. The founder of medical dialectics (and the real founder of the Bolognese school) was Taddeo Alderotti (1223-1303), called Thaddeus of Florence, a writer of dry scholia and good consilia. He was a prime mover in advancing the technic of postmortem examinations and consequently of dissecting.

The Conciliator differentiarum (Venice, 1471) of the heretic Peter of Abano (1250-1315), the great "Lombard", who as the title of his work implies, tried to reconcile the views of the Arabists and Grecians, marks the rise of the rival school of Padua as a centre of medical dialectics, of which Thaddeus and Peter were the patterns for a century.

The Liber Pandectae Medicinae of Matthaeus Sylvaticus (died 1342), of Mantua, one of the first medical incunabula to be printed (Strassburg, 1470 [?]) illustrates the conciliating tendency. The most prominent of

the Arabists, however, were associated with the rise of the medical school at Montpellier, which was founded about 738. A prominent early representative of the Arabist learnings was the Majorcan alchemist Raymond Lully (1235-1315) who, in addition to the philosopher's stone, sought the aurum potabile (liquid gold) as a sovereign elixir against disease. A man of more adventurous type was the Catalan Arnold of Villanova (1235-1311), a follower of the Arabian chemists, he also sought an universal elixir of life, and was one of the earliest European writers on alchemy.

Other prominent pupils of Montpellier were the surgeons Guy de Chauliac, Arderne, and Mondeville.

Before the advent of the Norman conquerors, English medicine was entirely in the hands of the Saxon leeches, whose practice was made up of charms, spells and herb-doctoring, and whose folk-medicine survives in Beowulf, the Leech-Book of Bald (circa 900-950), the Lacnunga (1100), Perididaxeon (1250), and other Anglo-Saxon "leechdoms." The Normans raised the social and intellectual status of the Anglo-Saxon physicians by having them educated abroad as clerics.

Bernard de Gordon, inferentially a Scotchman, did not practice in England, but was a teacher at Montpellier from 1285 to 1307. His Lilium Medicinae was first published at Venice (1496), and is a characteristic Arabist text-book of the practice of medicine. The Compendium medicinae (London, 1510) of Gilbertus Anglicus (died 1250), the leading exponent of Anglo-Norman medicine, is very much like Gordon's Lily in style.

He was the first to refer to smallpox as a contagious disease, a view afterwards contradicted even by Sydenham. John of Gaddesden (1280[?]-1361), a prebendary of St. Paul's, whom some think the original of Chaucer's Doctor of Physic, was physician to King Edward II of England. His Rosa Anglica, compiled in 1314, and printed at Pavia in 1492, contains an early reference to the red-light (Finsen) treatment of smallpox.

The most eminent naturalist of the 13th century was the Dominican monk, Albert von Bollstädt (1193-1280), called Albertus Magnus. He was the Aristotle of his period. His De vegetabilibus was based upon his own botanical observations and contains some therapeutic material. He did not write on medical practice, a subject forbidden the Dominicans. His pupil, Thomas Aquinas, discussed physiologic questions in his theologic writings and advanced the dubious animistic doctrine of qualitates occultae.

The greatest experimenter of the 13th century was the English Franciscan Roger Bacon (1214-94), who was a comparative philologist, mathematician, astronomer, physicist, physical geographer, chemist, and physician. He reformed the calendar, did much for the theory of lenses and vision, anticipated spectacles, the telescope, gunpowder, diving bells, locomotives and flying machines, and was a forerunner of inductive and experimental science. Medicine he regarded as a means of prolonging life through alchemy (chemistry) and he approved of astrology and other modes of superstition on account of their psychotherapeutic effect.

The pre-Renaissance medicine of the 14th and early 15th centuries was characterized by the attempt to cast the Arabist tradition into a rigid mould by means of Aristotelian dialectics and assimilation to the Aristotelian philosophy. A salient feature of clinical medicine in this period was the writing of "Consilia" or medical-case books. The earliest writer in this genre was Taddeo Alderotti, whose Consilia still "slumber in the manuscripts" (Sudhoff).

Of the scholastic writers on internal medicine, Guglielmo Corvi of Brescia (1250-1326), Dino del Garbo, Torrigiano di Torrigiani belonged to the School of Bologna. The rival School of Padua numbered among its masters Gentile da Foligno (died 1348), Giacomo de Dondi (1298-1359), and Matteo Silvatico of Mantua.

Before the invention of printing there had accumulated a huge quantity of medical literature in manuscript, the investigation of which has been mainly the work of Professor Karl Sudhoff and the Institute of Medical History at Leipzig.

The Montpellier School includes the names of Guy, Jean de Tournemire, Jean Jasme (Johannes Jacobi), and many other famous chancellors and Papal physicians. The leading medical writers of the early 15th century were Ugo Benzi, Antonio Cermisone, Savonarola, and Giammateo Ferrari da Grado (died 1472).

Cultural and Social Aspects of Mediaeval Medicine. - During the Dark Ages (476-1000), Western European civilization was in a chaotic, formless

state, the turbulent fermentation of barbaric or decadent peoples vaguely striving to resolve themselves into new nations. In the Dark Ages the clergy were the only class who had any pretense to education, and, before the time of the School of Salerno, medicine was entirely in the hands of Jewish and Arabian physicians. With the rise of the School of Salerno, European medicine began to look up a little but, as soon as monks and clerics began to practise medicine, it was found that the seeking of medical fees was detrimental to regular duties, so we find the Church instituting that long series of edicts, which, in the first instance, were aimed not so much at medicine as at its malpractice by monks. The general effect was, unfortunatley, not only to stop the monks from practising, but to extend the special odium of these decrees to the whole medical profession. The famous maxim of the Council of Tours (Ecclesia abhorret a sanguine), made the surgeon of better type still an inferior to the average practitioner.

Druidical medicine in Britain was entirely priestly. The Druids were a corporation of magicians, and of these, the Seer (vates) assumed iatromantic functions, with augury (inspection of sacrificial entrails) for prognosis; magic, and wort-cunning for therapy. Mistletoe (all-heal) was the panacea; the six herbs, lycopodium, pulsatilla, trifolium, primula, hyoscyamus, and verbena, were highly esteemed; artemisia, betony, bryonia, centauria, belladonna, hellebore, and mandragora were some of them, acquired

from Pliny. The Anglo-Saxon leechdoms tell the old story of charms, spells, and simples. Blood-letting, purging, and drugging were regulated by the moon's age. Ancient Irish medicine has many signs of Oriental provenance, particularly in the austere regulations of medical practice and quackery in the Brehon Laws, which suggest the Code Hammurabi.

In Tacitus (Germania, VII), it is said that the wounded Teutons sought their wives and mothers, who, like the professional bloodsuckers of the 18th century, applied their lips to the wounds. Demon-lore, magic, charms, and amulets made up the rest of early German medicine. Shepherds, herdsmen, and smiths, as being natural veterinarians, also became renowned as healers, bonesettlers, and masseurs (Streicher) in isolated localities.

In Russia, medicine was originally in the hands of the volkhava or wolf-men, who, like the Druids and wise women, culled medicinal herbs and resorted to charms and spells. After the introduction of Christianity in the 10th century, Russian medicine passed into the hands of the priesthood, and the Russian Church, like the Roman, put severe interdictions upon sorcery and magic. Religion, at the start, tended to improve the status of medicine but speedily, if unintentionally, degraded it when it found its own medical ministrants falling into evil ways. Under the legal restrictions of mediaeval times the surgeon worked daily and hourly in jeopardy of life or limb.

A striking illustration of the mediaeval neglect of surgery is to be found in the late appearance of artificial limbs, which were known to Herodotus and Pliny.

In the 13th century the Collège de Saint Côme was organized as a Paris guild. The members were divided into the clerical barber-surgeons or surgeons of the long robe, and the lay barbers or surgeons of the short robe. In 1372 Charles V decreed that the barbers should be allowed to treat wounds and not be interfered with by their long-robed confrères. The same thing happened in England.

In this way, barber-surgery (the surgery of the common people) became "wound-surgery," that is, was restricted to blood-letting and the healing of wounds.

In the year 1140, Roger II of Sicily issued an edict forbidding any one to practise medicine without proper examination. This important law was followed by an ordinance of larger scope issued by Roger's grandson, the generous and liberal-minded Hohenstauffen Emperor, Frederick II in 1224.

Frederick's edict required that a candidate for license to practise must be properly examined in public by the masters of Salerno. The examination was based upon the genuine books of Hippocrates, Galen and Avicenna. Food, drugs, and apothecaries' mixtures were examined at stated intervals by inspectors; and timely regulations were made in municipal hygiene and rural hygiene, such as for the proper depth of graves or the suitable disposal of refuse. The improvement of the medical profession was also furthered by the introduction of a new element - the rise and growth of the great mediaeval universities.

The earliest of these were at Paris (1110), Bologna (1158), Oxford (1167) and Montpellier (1181), Cambridge (1209), Padua (1222), Naples (1224) etc. It was through the influence of the mediaeval universities that the physician came to be regarded, in the end, as a member of a "learned profession". The favourite text-books were the Isagoge of Johannitius, Avicenna (i, iv), Rhazes' Liber medicinalis (ix) Galen's Ars parva and the Aphorisms, Prognostics, and Dietetics of Hippocrates. The term "doctor of medicine" was first applied to the Salernitan graduates by Gilles de Corbeil, in the 12th century.

From monastic institutions came the European botanic gardens (hortus) and physic-gardens (herbulares).

Medical ethics and medical etiquette were regulated in detail by sets of stereotyped rules, the earliest of which is the Formula comitis archiatrorum of Theodoric (5th century A.D.).

The chief glory of mediaeval medicine was undoubtedly in the organizati[on] of hospitals and sick-nursing. The credit of ministering to human sufferin[g] on an extended scale belongs to Christianity. In 369 the celebrated Basili[as] at Caesarea (Cappadocia) was founded by St. Basil, consisting of a large number of buildings, with houses for physicians and nurses, workshops and industrial schools. Hospitals arose at Ephesus, Constantinople, and elsewhere. These eventually became specialized for the care of the sick, for foundlings, for orphans, for the helpless poor.

After the death of Charlemagne, the larger hospitals began to decline through subdivision or loss of revenue and, in this period, we find the

monasteries, such as those of the Benedictine order at Cluny, Fulda and elsewhere, provided with private infirmaries and "eleemosynary hospitals". About the same time arose the various Catholic hospital orders, of which the earliest were the Parabolani; other orders were the Hospitallers, comprising the followers of St. Elizabeth of Hungary, who founded two hospitals at Eisenach with a third at Wartburg; the order of St. John of Jerusalem, which was founded when the Crusaders reached the Holy City in 1099; and the Teutonic Order. In 1145, Guy of Montpellier opened a hospital in honour of the Holy Ghost, which was approved by the Pope (1198), who himself built the hospital at Rome called "Santo Spirito in Sassia" in 1204. The example of the Pontiff was soon followed all over Europe. Another circumstance which vastly aided the city hospital movement was the immense spread of leprosy in the Middle Ages.

Leper hospitals were mentioned by Gregory of Tours (circa 560), and their advantages for purposes of segregation became apparent. Although in all the mediaeval hospitals nursing and seclusion was the rule, with absolute neglect of treatment, it is clear from Virchow's thoroughgoing narrative, that the building of the leprosoria represented a great social and hygienic movement, a wave of genuine prophylaxis as well as of human charity.

About the beginning of the 13th century, the hospital began to pass, without friction and by mutual agreement, from the hands of the ecclesiastic authorities into those of the municipality.

The great struggles for commercial supremacy were largely concerned

with the enormous profits derived from the drug-trade.

Perhaps the best available sidelights upon earlier mediaeval medicine are afforded in the miniature paintings which illuminate certain manuscript codices of the Salernitan masters, compiled and edited by Piero Giacosa in 1901. The theurgic therapy of mediaeval times, with its centric feature of a particular saint for each disease was a crude form of the doctrine of specificity. Uroscopy or water-casting was a favourite theme of the painter and woodengraver down to the beginning of the 18th century. The urinal became the emblem of medical practice in the Middle Ages, and was even used in some places as a sign-board device (Neuburger). The physician, of whatever period, is always represented as inspecting the urine in a most judicial way. The most striking cuts in Giacosa's collection, however, are the rude pen drawings from the Codex of Roland's Surgery in the Biblioteca Casanatense, representing different episodes in the surgeon's experience. The splendid series of manuscript pictures published by Sudhoff in his recent study of mediaeval surgery (1914) afford us a unique visualization of all phases of surgical practice in the 11th-15th centuries.

The Latin MS. Codex of Galen at Dresden (Db 92-93), which is assigned to the second half of the 15th century, contains beautiful miniatures illustrating the blue, ermine-bordered mantle of the mediaeval physician of rank, details of uroscopy, venesection, rectal irrigation, preparation of drugs, bedside scenes, and clinical and anatomic demonstrations.

In the 15th century there were numbers of pictures painted to represent scenes in the lying-in chamber.

Another important fact, thrown into relief by the 15th century pictures, is that the use of spectacles had by this time become quite common. They were introduced about 1270-80 by the glass-workers of Venice. The discovery of spectacle-lenses has been variously attributed to the Chinese, to the Romans, and to Roger Bacon. The truth is that the ancients, as Cicero, Cornelius Nepos, and Suetonius owned, were resigned, after fifty, to having MSS. read to them by slaves. In the Middle Ages, the Arabians alone made any advances in optics. In his Treasury of Optics, Ibn al Haitham or Alhazan (996-1038) notes refraction and the magnification of objects through a segment of a glass sphere, which Roger Bacon later proposed as a reading glass for weak-eyed and elderly people. Then, in the State Archives of Venice (1300-1301), edicts began to appear forbidding the manufacture of spectacles (ogli) out of any other than crystal glass. In a chronicle of the cloister of St. Catharine at Pisa (1305), it is stated that a monk Alessandro della Spina, could manufacture spectacles. As Greeff observes, most of the representations are anachronisms, for it was well after the invention of printing and the appearance of the incunabula, that spectacles came into common use. They were originally made from a smoky stone (berillus). During the 14th and 15th centuries, spectacles consisted of convex lenses in heavy unsightly frames.

During the Middle Ages European humanity was plagued with epidemic diseases as never before or since, and these were variously attributed to comets and other astral influences. The real predisposing factors were

the crowded condition and bad sanitation of the walled mediaeval towns; and the squalor, misrule, and gross immorality occasioned by the many wars. In the Middle Ages it was customary to regard eight diseases as contagious, viz., bubonic plague, phthisis, epilepsy, scabies, erysipelas, anthrax, trachoma leprosy (Sudhoff). Patients afflicted with these maladies were not permitted to enter cities, or were isolated, if inside cities. The idea of contagion in nervous diseases acquired considerable momentum from such neurotic manifestations of crowd psychology as epidemic chorea (later known variously as St. Vitus's Dance, danse de St. Guy, and the Dancing Mania), the Children's Crusade, the processions of Flagellants and, with some reservations, the major Crusades themselves.

The earliest of the great mediaeval pandemics were the leprosy, Saint Anthony's fire or ergotism (857), scurvy (1218), the "Dancing Mania" (epidemic chorea), sweating sickness, which was probably a form of influenza, plica Polonica (1287), and - most formidable of all - the Black Death and syphilis. Of these, leprosy, scurvy and influenza were either introduced or spread by the Crusades. With regard to the last of these a cosmic, telluric or celestial "influence" (Influentia coeli), whence its name influenza, was first suggested in Buoninseghi's History of Florence (1580), with reference to an epidemic of 1357. Chorea (dancing mania) was probably the result of physical degeneracy plus fanatical religious enthusiasm, and acquired the name of St. Vitus's Dance from the processions of dancing patients in the Strassburg epidemic of 1418, who proceeded in this wise to the Chapel of St. Vitus in Zabern for treatment. Plica Polonica, the unsightly disease of matted hair, was introduced into Poland by the Mongol

invasion (1287). A diphtheria epidemic of 1492 is described by the Nuremberg city physician Hartmann Scheled. Ergotism, variously known as ignis sacer, ignis infernalis, or St. Anthony's fire, was often as not erysipelas, but usually a characteristic disease of the Middle Ages due to the formation of the fungus Claviceps purpurea in spur-shaped masses upon rye, the common bread of the poorer classes. The so-called mal des ardents was probably the plague. The correlation of famine and (typhus) fever had already been noted in the Anglo-Saxon Chronicle (1087). Stow's Survey of London notes the deaths of the jailors of Newgate and Ludgate and of 64 prisoners, doubtless from lice-transmitted typhus.

During the 9th-12th centuries, there were many prayers, conjurations, charms and amulets against a strange periodic affection called Malum Malannum. It was a serpiginous carbuncular or gangrenous eruption, possibly identical with glanders or anthrax.

The Black Death, which caused the unprecedented mortality of one-fourth of the population of the earth (over sixty millions of human beings), appeared in Europe about 1348, after devastating Asia and Africa. The epidemic had at least one good effect, that it led the Venetian Republic to appoint three guardians of public health (1348) to exclude infected and suspected ships (1374), and to make the first quarantine of infected areas (1403), so called because travellers from the Levant were isolated in a detention hospital for 40 days (quaranta giorni). In other cities there

were plague ordinances and private personal directions (Pestschriften), pesthouses and other hygienic improvements. If plague supervened, phlebotomy was the therapeutic sheet-anchor.

The other great scourge of the Middle Ages was syphilis, which was supposed to have first appeared in epidemic form at the siege of Naples in 1495, and to have been communicated to the French invaders by the Spanish occupants, who got it (authorities conjecture) from Columbus's sailors, a visitation from the New World. The supposed Neapolitan epidemic of 1495-6 Sudhoff holds to have been an outbreak of typhoid or paratyphoid infection. Syphilis is first mentioned in:

1. The Edict against Blasphemers (Gotteslästereredikt) of Emperor Maximilian I, issued August 7, 1495.

2. The Vaticinium or "astrological vision" of the Frisian poet-physician Theodoricus Ulsenius (Dietrich Uelzen), printed at Nuremberg August 1, 1496.

3. The Eulogium, a poem by Sebastian Brant, printed in September, 1496.

All these tracts tend to show, Sudhoff thinks, that syphilis was known in Europe before the siege of Naples.

The first reference to the supposed West Indian origin of syphilis is contained in a work of Diaz de Isla (Tractado contra el mal serpentino), written about 1510. Virchow maintained that the caries sicca of prehistoric and pre-Columbian skulls was not true syphilis but either identical with the arthritis deformans (Höhengicht) of old cave-bears, or else caused by plants and insects. Mediaeval syphilis was first known as mal franzoso, morbus

gallicus or mala napoletana, after the supposititious siege of Naples (1495), where it was supposed to have been communicated to the French soldiers under Charles VIII by the Spanish immigrants. Sudhoff gives a large number of recipes for syphilis, indicating that, far from being helpless in the treatment of the disease, physicians at the end of the 14th century were already prescribing the mercurial inunctions, which had been used as far back as the 12th century for an indefinable class of skin eruptions, comprising leprosy, psoriasis, and eczema. Mercurial salves were recommended for dermal eruptions by all mediaeval surgeons, from Roger down. Syphilis may have been endemic in Italy as early as 1429. The Naples epidemic itself was a typhoidal infection like most of the febres pestilentiales.

The end-result of Sudhoff's investigations is to the effect that from the 12th century on, mediaeval physicians were richly supplied with mercurial recipes against an anomalous group of chronic skin affections, which, from their very names - scabies grossa, variola grossa, grosse vérole, scabies mala, böse Blattern, mal franzoso - were most likely syphilitic.

After the disease became pandemic, its sexual origin was recognized. Apart from wars and famine, and even up to Ehrlich's time, syphilis has held its own with tuberculosis and alcoholism as a prime factor in bringing about the degeneration of the human stock.

THE PERIOD OF THE RENAISSANCE, THE REVIVAL OF LEARNING, AND THE REFORMATION (1453-1600)

In the transition of civilized mankind from mediaeval to modern conditions, many forces were operative, but undoubtedly the most potent for the growth of individualism and release from the ban of authority were the inventions of gunpowder (which gave the coup de grace to feudalism), and of printing. With the discovery of America, the doubling of the Cape of Good Hope by Vasco da Gama, Magellan's circumnavigation of the globe, the establishment of heliocentric astronomy by Copernicus, and the Reformation, free thought came into its own again, and the critical spirit grew apace. The effect of the revival of Greek culture was to substitute the spontaneous receptive attitude of Plato and Hippocrates for the dialectics and logic-chopping of Aristotle and the Galenists. Among the neo-Platonists, Leonardo da Vinci and Nicholas Cusanus were eminent in physics. The physician Jean Fernel, an accomplished mathematician, made the first exact measurement of a degree of the meridian. The sack of Mainz, by Adolph of Nassau (1462), scattered the German printers over Europe. The Gutenberg Bible was printed in 1454. William Caxton began to print in English about 1474-5. With the medical philologists came the critical, questioning spirit in medicine.

Of the medical humanists, Niccolò Leoniceno (Leonicenus), (1428-1524), made a famous translation of the Aphorisms of Hippocrates, but his chief service to science lay in the difficult task of correcting the botanical errors in the Natural History of Pliny.

Thomas Linacre (1460-1524) is remembered especially for his grammatic works, foundations of lectures on medicine at Oxford and Cambridge (1524), and Latin versions of Galen's treatises on hygiene (1517), therapeutics (1519), temperaments (1521), natural faculties (1523), the pulse (1523), and semeiology (1524).

One of the earliest of the French humanists was Symphorien Champier (1472-1539), of Lyons, who wrote the earliest and best history of medicine in his time (1508).

François Rabelais (1490-1553), who, like Linacre, was a priest as well as a physician, made one of the first Latin translations of the aphorisms of Hippocrates. He is best known by his immortal humorous works "Gargantua" and "Pantagruel".

Jean Fernel (1506-88), of Clermont (Oise), a Paris graduate of 1528-30, was the greatest French physician of the Renaissance. He made the best classification of diseases between Galen and Felix Platter.

Anutius Foesius, or Foes (1528-95), devoted forty years of a laborious life to his invaluable concordance of Hippocrates (Œconomia Hippocratis, 1588).

Some time after the invention of printing, Germany entered the field

of medicine with a remarkable array of semipopular treatises. A unique copy of a Calendar for Blood-Letting (Aderlasskalender), printed at Mainz in 1462, is one of the treasures of the Fürstenberg Library at Donaueschingen (Baden). These popular almanacs, consisting of loose leaves or broadsides, printed on one side only, show the hold which judicial astrology (the Lasstafelkunst) had taken upon the people. Palmistry also attracted wide attention. The Versehung des Leibs (Nuremberg, 1489) contains the first book plate, a picture of a man with the facies Hippocratica.

In 1513 there appeared, at Worms, the Rosegarten of Eucharius Röslin, a work which bears about the same relation to Renaissance obstetrics that the Anothomia of Mundinus does to mediaeval anatomy. Röslin's text was miserably plagiarized by Walther Reiff in 1545, and also translated and reissued by Thomas Raynalde as The Byrthe of Mankynde, London, 1545.

Perhaps the earliest European text of medical jurisprudence of consequence is the "Constitutio Criminalis Carolina", issued in 1533. Early German botany had its beginnings in the Herbarius Moguntinus (Mainz, 1484).

Early German surgery begins with the Bündth-Ertznei of Heinrich von Pfolspeundt. He was only a wound surgeon, had no skill in the major operations, he did not know how to treat fractures and dislocations; but he learned how to make artificial noses (by the Hindu method) from the wandering Italians. He treated wounds by second intention, used the narcotic recommended by Nicholas of Salerno, and, like Mondeville and other surgeons of earlier times, gave his patients strengthening "wound-drinks". The

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Buch der Wund-Artzney (Strassburg, 1497) of Brunschwig contains the first detailed account of gunshot wounds in medical literature. He regarded such wounds as poisoned, and thought the poison could be best removed by promoting suppuration, usually by means of the seton. In performing amputation, he applied the actual cautery or boiling oil to check haemorrhage from the stump. Gersdorff goes even more fully into gunshot wounds. He did not regard them as poisonous, but probed for the bullet with special instruments and, like most surgeons of his time, poured hot oil into the wound. Gersdorff's book contains some of the most instructive pictures of early surgical procedure in existence; in particular, the first picture ever made of an amputation, and unique plates of leprosy and St. Anthony's fire. Another interesting picture book in the vernacular is the Augendienst (Dresden, 1583) of the court oculist, George Bartisch (1535-1606), the striking illustrations of which afford a complete purview of Renaissance eye-surgery. The earliest printed book on the eye was the De oculis, eorumque egritudinibus et curis of Benvenuto (printed at Ferrara in 1475), which follows the ancients.

The first medical book to be printed in England was called A Passing Gode Lityll Boke Necessarye and Behovefull Agenst the Pestilence, translated from the Tractatus contra pestilentiam (1480). Next came The Governayle of Helthe, printed at Caxton's press about 1491, followed by The Judycyal of Urins (1510), sometimes attributed to John of Arderne.

In 1516, Peter Treverus, a printer in Southwark, published The Grete Herball. The first work on anatomy to be printed in England was David Egar's little tract of 15 pages, entitled In antomicen introductio luculenta et brevis. The first English anatomy printed in the vernacular was The Englishman's Treasure by Thomas Vicary (London, 1548[?]-1577).

The effect of these vernacular writings was to get men's minds away from scholasticism and turn them towards realities. This Renaissance tendency reached its highest development in the great medical leaders of the 16th century, Paracelsus, Vesalius, and Paré.

Aureolus Theophrastus Bombastus von Hohenheim, or Paracelsus (1493-1541), the most original medical thinker of the 16th century, was, in spite of his bombastic assertion of rank and lineage, a striking example of the very raw materials from which such aspirations are sometimes fashioned. A native of Einsiedeln, near Zürich, Switzerland, he had the truculent, independent spirit commonly ascribed to the man of mountaineer race. He tried to bully and browbeat his auditors and readers into accepting his views. He got his doctor's degree under Leonicenus at Ferrara (1515), and travelled all over Europe, collecting information from every source. Appointed professor of medicine and city physician at Basel (1527), and imbued with a lifelong reverence for Hippocrates, implanted by his teacher Leonicenus, he began his campaign of reform by publicly burning the works of Galen and Avicenna in a bonfire and lecturing in German out of his own experience. As

a pioneer in chemistry, Paracelsus was preceded by pseudo-Geber, the alchemists Albertus Magnus and Cornelius Agrippa, and followed by Johann Thölde, who wrote under the pseudonym of Basil Valentine. Pseudo-Valentine is supposed to have given to chemistry hydrochloric acid, sugar of lead, the means of preparing ammonia and sulphuric acid and, in his "Triumphal Chariot of Antimony" (1604) fastened the latter metal upon medical practice for centuries. Paracelsus took Geber's three chemical elements - combustible sulphur, volatile mercury, residual salt - and mixed them up with a species of theosophic lore. Existence proceeds from God, all material things from the Yliaster (primordial substance), while the force in nature which sets things going (the vital principle) is the Archaeus. Diseases, in Paracelsus's scheme of things, were caused by astral influences acting upon the "astral body".

Far in advance of his time, Paracelsus discarded Galenism and the four humours; he was the first to write on diathetic (tartaric) and miners' (occupational) diseases, and the first to establish a correlation between cretinism and endemic goitre. Almost the only asepsist between Mondeville and Lister, he taught the unity of medicine and surgery, and that nature (the "natural balsam") heals wounds, and not officious meddling. As a theorist, Paracelsus believed in the descent of living organisms from the primordial ooze (Urschleim), and Baas credits him with anticipating Darwin. Paracelsus was great in respect of his own time. He does not seem parti-

cularly great in relation to our time.

The principal works of Paracelsus are the treatise on open wounds (1528), his Chirurgia magna (1536), his manual introducing the use of mercurials in syphilis (Frankfurt, 1553), the treatise De gradibus (Basel, 1568), which contains most of his innovations in chemical therapeutics, his monograph on miners' diseases (Von der Bergsucht, Dilingen 1567), and his booklet on mineral baths (Basel, 1576).

In his chapter, De generatione stultorum, he first notes the coincidence of cretinism and endemic goitre, a discovery also based upon original observations in the Salzburg region.

The most remarkable clinical contributions are the original descriptions of typhus fever by Fracastorius (1546), of sweating sickness by Caius (1552), of varicella by Ingrassias (1553), of tabardillo (Spanish or Mexican typhus) by Francesco Bravo (1570), of whooping-cough ("quinta") by Guillaume Baillou or Ballonius (1578), of chlorosis (morbus virgineus) in the epistles of Johann Lange (1554), and of the syndrome "mountain sickness" by the Jesuit traveller José d'Acosta (1590). Geronimo Mercuriali (1530-1606) wrote the first systematic treatise on skin diseases (1572). Savonarola is credited with the first incunable on balneology (1489).

Guillaume de Baillou (1538-1616), a Paris graduate of 1570, whom Henri IV chose as physician to the Dauphin, and who first described whooping-cough (1578) and introduced the term "rheumatism," is regarded by Crookshank as "the first epidemiologist of modern times."

Charles Singer points out that some beginnings of tropical medicine were made in Oviedo's description of yaws as "bubas". Oviedo and Thevet also mention the sandflea (Pulex penetrans). Singer draws attention to the first book on tropical medicine, by George Wateson, entitled The Cures of the Diseased in Remote Regions (London, 1598).

For a long time after Paracelsus chemistry still remained alchemy and, in the following century, became merged into the fantastic pseudo-science of the Rosicrucians. The arch-patron of alchemy in the 16th century was the Emperor Rudolph II of Germany (1576-1612), who devoted much of his fortune and the whole of his reign to the quest of potable gold, the philosopher's stone, and the elixir of life. In the spacious and gloomy chambers of his palace, the Hradschin at Prague, he held high court with alchemists, spiritualists, judicial astrologers, clairvoyants, and other followers of psychic "science". Hither came the learned Cambridge scholar, John Dee, a solemn humbug, and his assistant, Edward Kelly, a sharp-witted impostor. Libavius (1546-1616), a physician and teacher of Coburg, made a real start in chemistry. He discovered stannic chlorid, analyzed mineral waters with the balance (1597), wrote a city pharmacopoeia (1606), and was one of the first to suggest the transfusion of blood (1615).

Geronimo Cardano (1501-76) practised medicine and professed mathematics at Milan. His best work is his natural history (De subtilitate rerum, 1550). It contains a device for teaching the blind to read and write by the sense of touch, which is not very different from the modern invention of Braille (1829-36). Jerome Cardan also saw the possibility of teaching the deaf by signs.

That the phenomena of hypnotism, autosuggestion and psychotherapy were well known in the 16th century is apparent from the writings of Pomponazzi, Cornelius Agrippa, Cardan, Van Helmont, and Kircher.

After the time of Mundinus, a number of treatises and plates appeared, containing the first rude attempts at pictorial representation of dissected parts. These are the so-called "graphic incunabula" of anatomy and may conveniently take in all published illustrations of the pre-Vesalian period.

It has been shown, in the highly exhaustive researches of Karl Sudhoff, that none of these earlier anatomic illustrations are based upon original observation. It was customary for the mediaeval illustrators to make a series of five schematic pictures (Fünfbilderserie), representing the osseous, nervous, muscular, venous, and arterial systems, to which the pregnant woman or a view of the generative organs of either sex was sometimes added. The curious half-crouching posture, that of a reflex frog or a child's jumping-jack, is found even in the acupuncture manikins of ancient Chinese medicine (Hsieh). Peter of Abano's Conciliator (1496) contains the first example of the "Muskelmann", i.e., a full-length figure exhibiting its dissected muscles. In the works of Berengario da Carpi, who was the first to substitute drawing from nature for traditional schemata, this figure is represented as holding up the separate muscles for inspection. These tentative efforts at representation, rare and curious as they are, pale almost into obscurity beside the cartoons, écorchés, and chalk drawings of the great artists of the period - Luca Signorelli, Michael Angelo, Raphael, Verocchio, and his pupil, Leonardo da Vinci.

The temperamental 14th century Florentine was a "half-baked scientist". All the great works on perspective and human proportion, except Dürer's, came from Florence. An interest in dissecting probably came about through the fact that the painters formed a sub-species of the Florentine "Guild of Physicians and Apothecaries". On the textual side, the continuum between Mundino and Leonardo is filled in part by the anatomists Gabriele Zerbi (1468-1505), of Verona, Professor at Padua, who wrote an anatomic treatise (1502), Alessandro Benedetti (1460-1525), founder of the anatomic theatre at Padua, Alessandro Achillini (1463-1512), of Bologna, Berengario da Carpi (1470-1550), and Marc Antonio della Torre (1481-1512).

Leonardo da Vinci (1452-1519), the greatest artist and scientist of the Italian Renaissance, was the founder of iconographic and physiologic anatomy. Startlingly modern in their accuracy and display of physiologic knowledge, his impromptu sketches, made beside the dissected subject, reveal such acquaintance with muscular anatomy as was possible only to the Greek sculptors, and fully justify William Hunter's claim that their author was "the greatest anatomist of his epoch". Leonardo believed that a scientific knowledge of artistic anatomy can be gained only at the dissecting table. Remarkable are his studies of the bones, the skull, the spine, the valves, muscles and vessels of the heart, his discovery of the atrioventricular band in the right heart, his cross-sections of the brain and casts of its ventricles. The marginal notes, which Leonardo has recorded in mirror-writing, perhaps lest others appropriate his ideas, suggest the cautious,

secretive spirit of the time.

Albrecht Dürer's treatise on human proportion is technically interesting as containing the first attempts to represent shades and shadows in wood-engraving by means of cross-hatching.

Dissecting for teaching purposes was still hampered by the theologic idea of the sanctity of the human body and its resurrection. The anatomy of the schools was still the anatomy of Galen. Andreas Vesalius (1514-64), the most commanding figure in European medicine after Galen and before Harvey, alone made anatomy what it is to-day - a living, working science. Flemish born, but of German extraction, a pupil of that ardent and bigoted Galenist, Jacobus Sylvius, Vesalius soon established a reputation for first-hand knowledge of the dissected human body. Five years' experience as public prosector at Padua, where he taught students to dissect and inspect the parts _in situ_, culminated in the magnificent _De Fabrica Humani Corporis_ (1543), a work which marks an epoch in breaking with the past and throwing overboard Galenical tradition. The effect of a publication so radical on a superstitious and forelock-pulling age was immediate and self-evident. He was subjected to subterranean persecution at the instance of authority. In a fit of indignation he burned his manuscripts, left Padua, and accepted the lucrative post of court physician to Emperor Charles V. He paid the penalty of "the great refusal" when his favourite pupil, Gabriele Falloppio, came to the front as a worthy successor.

In the year 1563, Vesalius set out on a pilgrimage to Jerusalem. On

his way back, in 1564, he received word of an invitation to resume his old chair at Padua, just vacated by the death of Fallopius. But his highest wish to "once more be able to study that true Bible, as we count it, of the human body and of the nature of man," was not to be realized. The sudden access of an obscure malady left Vesalius to die, solitary and unfriended, on the island of Zante.

The principal works of Vesalius include six anatomic plates (Tabulae anatomicae) printed at Venice in 1538.

What fate might have befallen Vesalius had he gone further is sensed in the case of the heretic Miguel Servede or Servetus (1509-53) whom Calvin caused to be burned at the stake for a mere juggling of verbiage, a theologic quibble. His discovery that the blood in the pulmonary circulation passes into the heart, after having been mixed with air in the lungs is recorded in his book, the Restitutio Christianismi (1553).

Eustachius (1524-74), was professor at the Collegia della Sapienza in Rome, where, in 1552, he completed his Tabulae anatomicae (a set of superb plates drawn by himself) which remained unprinted in the Papal Library for 162 years. Finally, Pope Clement XI presented the engraved plates to his physician Lancisi, who, by the advice of Morgagni, published them with his own notes in 1714. They were the first anatomic plates on copper. Eustachius discovered the Eustachian tube, the thoracic duct, the suprarenal bodies (1563), and the abducens nerve.

Jacques Dubois (1478-1555), called Sylvius, Vesalius' teacher at Paris,

was, in spite of his large following of pupils, a harsh, avaricious bigot, whose devotion to Galen was such that he declared Vesalius to be a madman (vesanus). Sylvius was one of the first to mention the Sylvian aqueduct and the valves in the veins.

The other opponent of Vesalius, Matteo Realdo Colombo (1516?-59), called Columbus, is sometimes spoken of as the discoverer of the pulmonary circulation, but the work in which his undoubtedly excellent account is contained (his De re anatomica) was published in 1559, at least six years after the burning of Servetus and his book.

Canano (1515-79), of Ferrara, published some 26 copper-plates of the bones and muscles of the arm and forearm, but having seen the unpublished wood-cuts of the Fabrica, the high-minded Ferrarese deliberately suppressed his own book.

Gabriele Falloppio (1523-62), or Fallopius, a loyal pupil of Vesalius, discovered and described the chorda tympani, the semicircular canals, the sphenoid sinus, the ovaries (Fallopian tubes), the round ligaments, the trigeminal, auditory, and glossopharyngeal nerves, and named the vagina and placenta. He was also a versatile writer on surgery, syphilis, mineral waters, and other subjects. His pupil, Heronymus Fabricius ab Aquapendente (1537-1619), was Harvey's teacher at Padua.

Through the work of Leonardo and Vesalius anatomy became the starting point of modern medicine.

The effect of Vesalius on Renaissance surgery is apparent in the life

work of Ambroïse Paré (1510-90), who made the Fabrica popular and accessible to surgeons by writing an epitome of it in the vernacular. Paré became an army surgeon in 1537, and soon made himself the greatest surgeon of his time. Brantôme and Sully record that he was the only "Protestant" to be spared (by royal mandate) at St. Bartholomew. Had it not been for his "fat of puppy-dogs," a lard or salve which, from some tenacity of superstition, he continued to apply, he would have been a true follower of Hugh, Theodoric, and Mondeville in the aseptic management of wounds.

Paré invented many new surgical instruments, made amputation what it is to-day by reintroducing the ligature; was the first to popularize the use of the truss in hernia; and introduced massage, artificial limbs, and artificial eyes (of gold and silver). He described fracture of the neck of the femur and strangury from hypertrophy of the prostate, and was the first to suggest syphilis as a cause of aneurysm. He was probably also the first to see flies as transmitters of infectious disease. He described monoxide poisoning. A curious book is his treatise on monsters, terrestrial and marine (1573), embellished with pictures of many of the strange, hypothetic creatures which emanated from the brain of Aristotle.

Tagliacozzi (1546-99) revived the operation of rhinoplasty which, during the 15th century, had been in the hands of a Sicilian family of plastic surgeons - the Brancas of Catania. In 1788 the Paris Faculty interdicted face-repairing altogether. In this way, plastic surgery fell into disrepute and disuse until the time of Dieffenbach. The great Provençal surgeon

Pierro Franco (<u>circa</u> 1500), did even more than Paré to put the operations for hernia, stone, and cataract upon a definite and dignified basis (1556-61) and was the first to perform suprapubic cystotomy (1556). Another remarkable herniotomist and cataract-coucher, long forgotton, was Caspar Stromayr of Lindau, whose fascinating <u>Practica Copiosa</u> (1559), recently was printed from the original MS. by Walter von Brunn (Berlin, 1925). Felix Würtz (1518-75) was a follower of Paracelsus in the simple treatment of wounds, and a vigorous opponent of the common custom of thrusting "clouts and rags, balsam, oil, or salve" into them. Francisco Diaz published the first treatise on diseases of the kidney, bladder, and urethra (1588).

William Clowes (1540-1604) was probably the greatest of the English surgeons during the reign of Elizabeth.

The Scotch army surgeon, Peter Lowe, founded the Faculty of Physicians and Surgeons of Glasgow (1599), and made the first English translation of Hippocrates (1597).

In the year 1500 Jacob Nufer, a sow-gelder, performed a successful Caesarean section upon his own wife.

The eager, inquiring spirit of Renaissance humanity is sensed in the immense popularity of such a work as the <u>Hortus Sanitatis</u> (1491), with its quaint, coloured wood-cuts of real or fanciful animals and plants. This was soon followed by a number of genuinely scientific treatises on botany and by extensive "Bestiaries", or animal-books.

Plant description, or phytography took its first fresh start since the

days of Theophrastus in the work of Hieronymus Bock (1498-1554), called Tragus. Tragus loved plants for themselves and, in his New Kreutterbuch (1539), and in his Kreutterbuch of 1546, wrote down in the vernacular his fresh first-hand descriptions of what he saw. A far greater than Tragus was Valerius Cordus (1515-44), he is known to medicine for his discovery of sulphuric ether. Greene styles him "the inventor of phytography".

A remarkable Renaissance figure was Conrad Gesner (1516-65), of Zurich, whom Cuvier called "the German Pliny," on account of his equal attainment in botany, zoölogy, bibliography, and general erudition. His Historia Plantarum (Paris, 1541), is a student's handbook of botany. His Historia Animalium was subsequently translated into German as the Thierbuch, and became one of the starting-points of modern zoölogy.

Caspar Bauhin (1550-1624) was professor of anatomy, botany, medicine and Greek at Basel. His greatest work is the celebrated "Pinax" (1596), a wonderful index or compend of all the botanic literature up to his time.

The earliest English contributions to botany were the "Herbals" of Peter Treverus (1516), Richard Banckes (1525), Thomas Petyt (1541), William Middleton (1546), William Turner called the Father of English Botany (1551), and of the barber-surgeon John Gerard (1597).

Andrea Cesalpino (1524-1603), a professor of medicine at Pisa, and physician to Pope Clement VIII, is regarded by the Italians as a discoverer of the circulation (1571-93) before Harvey (1616). Cesalpinus had indeed grasped,

as pure theory, the truth about the systemic and pulmonary circulations. But his ideas were not supported by any convincing experiments. He was called by Linnaeus the first true systematist (primus verus systematicus) in botany.

Giovanni Battista della Porta (1536-1615) of Naples, who invented the camera obscura (1588), described the opera glass (1590), and was one of the principal founders of optics, was also an opponent of witchcraft.

Pierre Brissot (1478-1522) stands out as a reformer in the practice of bloodletting. He made a stand for the original Hippocratic method of "derivative" bloodletting, that is, free venesection on the same side as and near to the lesion.

A gifted pathologist was the distinguished Florentine, Antonio Benivieni (-1502). In his posthumous De Abditis Causis Morborum published by the Giunti (1507), he appears as a founder of pathology before Morgagni. Girolamo Fracastoro, Fracastorius, (1484-1553), a Veronese, was at once a physician, poet, physicist, geologist, astronomer, and pathologist, and shares with Leonardo da Vinci the honour of being the first geologist to see fossil remains in the true light (1530). His medical fame rests upon that most celebrated of medical poems, Syphilis sive Morbus Gallicus; and his treatise, De Contagione (1546), in which he states, with wonderful clairvoyance, the modern theory of infection by microörganisms (seminaria contagionum) and describes (lib.III) an epidemic of foot-and-mouth disease (1514).

The account of Renaissance medicine may close with the works of two original characters who were not physicians: the Venetian, Luigi Cornaro

whose Trattato della vita sobria (Padua, 1558) is probably the best treatise on personal hygiene and the "simple life" in existence; and The Metamorphosis of Ajax (1596) of Sir John Harington (1561-1612).

The first medical and surgical books to be published in the new world, such as the Opera Medicinalia of Francisco Bravo (1570), the Summa y Recopilacion de Cirugia of Alphonso Lopez de Hinojoso (1578; 2ed., 1595), and the Tractado Breve de Medicina of Fray Augustin Farfán (1592) were printed in the city of Mexico.

CULTURAL AND SOCIAL ASPECTS OF RENAISSANCE MEDICINE

The Byzantine Greek Scholars, who poured into Italy after the destruction of Constantinople, have been described as "sowers of dragon's teeth," and if we judge them by their effect upon the work of Paracelsus, Vesalius, and Paré, we may regard these Humanists as the true forerunners of modern medicine. In the different universities, the courses of medical instruction and the text-books used - Avicenna's Canon, Galen's Ars parva, the Aphorisms of Hippocrates, Dioscorides - remained about the same, but new and important features were gradually introduced. Bologna, Padua, and Pisa had the most popular medical faculties, and after them Paris, Montpellier, and Basel.

The principal innovations in medical teaching were in the disciplines of anatomy and botany. Postmortem sections before students were tried upon defunct obstetric patients at Padua by Marco Oddi (1579), but these were soon done away with by popular prejudice. Dissections, however, became more

frequent and were regarded in each case as a particular and expensive social function, for which a special papal indulgence was necessary. Having been taken into the anatomic hall, the cadaver was beheaded in deference to the then universal prejudice against opening the cranial cavity. In 1564, John Caius obtained from Queen Elizabeth a formal grant of two bodies of criminals for dissections by the two holders of medical fellowships at Cambridge.

Medical practice during the Renaissance period was bound up with superstition, herb-doctoring, and quackery. In the illustrations of the period, the physician, whether in long robe or short fur-edged pelisse, is invariably represented as inspecting a urinal. He usually believed in astrolog and went in for the lore of amulets, or the determination of the proper time for purging and blood-letting by the conjunction of the planets. We may judge of the true greatness of men like Vesalius, Leonicenus, Linacre, Fracastorius, and Benivieni by reflecting that they alone scorned to credit these things. In like manner only the surgeons of first rank - Paré, Gersdorff, Franco, Würtz, Tagliacozzi, Clowes and Bartisch - were true surgeons

Perhaps the worst phase of Renaissance medical practice was its obstetrics. In normal labour, a woman had an even chance if she did not succumb to puerperal fever or eclampsia. The high rate of infant mortality was due to the low status of public, domestic, and personal hygiene, which was held in less regard than in the Middle Ages.

The first judicial postmortem in France was made by Ambroïse Paré

in 1562. In 1547 the monastery of St. Mary of Bethlehem at London (founded in 1246) was converted into a hospital for the insane, popularly known as "Bedlam", and in a few years was amply justifying its reputation as conveyed in this term.

A special feature of Renaissance legislation in France and England was the improvements of the status of the barber-surgeons. In 1540, under Henry VIII, the Barber Company was united with the small and exclusive Guild of Surgeons to form the United Barber-Surgeon Company, with the anatomist, Thomas Vicary as its first Master. In 1546, the king also founded the Regius Professorship of Medicine at Cambridge.

The English act of 1511 (3. Henry VIII, cap.iii) decreed that no one should practice medicine or surgery in London, or seven miles around and about it, without being first examined, approved and admitted by four doctors of physic or expert surgeons, acting under the Bishop of London or the Dean of St. Paul's. Beyond the seven miles precinct, the applicant must be approved by similar bodies under the bishop of the diocese or his vicar general. In 1542-3, Acts 34 and 35, Henry VIII, cap.8, were enacted, permitting common persons having knowledge of herbal and folk-medicine to minister to the indigent.

During the Renaissance period, considerable advance was made in the theory and practice of military medicine.

Of the many epidemic diseases which had beset Europe in the Middle Ages, three, the sweating sickness, leprosy, and epidemic chorea, had well-nigh dis-

appeared by the middle of the 16th century. The most formidable epidemics were the plague and syphilis. Wittenberg and some of the other cities commenorated the different epidemics by striking off special coins, or pest-dollars (Wittenberger Pesttaler). Wittenberg pest-dollars and the "Zenechton," arsenic-paste sewed up in dog-skin, were worn over the heart as amulets against the plague.

Syphilis was less malignant in character than in the 15th century. Mercury had become the great sheet-anchor. As alchemy introduced antimony, mercury, and sugar of lead, so the discovery of America brought in guaiac (introduced in 1508-17), the root of China smilax (1525), exploited by Vesalius, sarsaparilla (1536), and sassafras. Gonorrhea became common about 1520. One remarkable effect of the venereal diseases was the supression of common public baths for either sex or both sexes.

Examples of medical illustration in Renaissance art are Orcagna's grisly procession of lepers in his "Triumph of Death" and the elder Holbein's picture of St. Elizabeth ministering to three lepers.

Of epidemic diseases, smallpox and measles began to appear in the northern countries, notably in Germany (1493) and Sweden (1578). Lead-poisoning appeared in the south of France. Scurvy, which appeared as early as 1218, was first described by Jacques de Vitry and Joinville (1250), and later in the narrative of Vasco da Gama's voyage (1498). Yellow fever is said to have exterminated the population of Ysabella, San Domingo, in 1493. Typhus

fever was epidemic in Italy in 1505 and 1524-30, and was described by Fracastorius (1533) and Francisco Bravo (1570). As "gaol fever," it devastated the court-rooms of the famous Black Assizes of Cambridge (1522), Oxford (1577), and Exeter (1589) by obvious lice transmission from the prisoners on trial. The so-called Hungarian disease (morbus Hungaricus), which spread all over Europe in 1501 and in 1505-87, was frequently epidemic in Italy and France, is now regarded as, in all probability, typhus fever. Diphtheria, which had already been described by Schedel in 1492, was six times epidemic in Spain during the period 1581-1638, and by 1618 had spread to Italy. Ergotism, in the gangrenous form, was prevalent in Spain in 1581 and 1590. The epidemics of sweating sickness (sudor Anglicus) which prevailed in 1528-9 were probably influenza. In the opinion of Crookshank, the epidemic agues of Le Paulmier (1578) were not malarial, but influenzal.

In the 16th century the Eastern drug-trade, the quest for

> "Cassia, sandal-buds and stripes
> of Labdanum, and aloe-balls"

fell into the hands of the Portuguese navigators.

Hospital construction approached perfection in the 15th century. Three famous English institutions of the period were the Hospital of St. Mary of Bethlehem, which was converted from a monastery into an insane asylum ("Bedlam") in 1547; Bridewell, anciently a palace, which became a penitentiary and house of correction for vagabonds and loose women in 1553; and Christ's hospital, formerly the Grey Friars Monastery, which was chartered in 1553 as a charity for fatherless and motherless children, and became the famous school of the "Blue Coat Boys", at which Charles Lamb and Coleridge were educated.

THE SEVENTEENTH CENTURY; THE AGE OF INDIVIDUAL SCIENTIFIC ENDEAVOUR

The 17th century was preeminently a period of intense individualism, intellectual and spiritual. The great philosophers of the time, Spinoza, Bacon, Descartes, Locke, were all of them concerned with different aspects of natural science. Yet with the decline of collectivism there necessarily went a corresponding decline in the things which had thrived under its régime, in particular, organized nursing, charitable care of the sick, and well managed hospitals to this end.

In the 17th century the German people, decimated and torn asunder by the ravages of the Thirty Years' War, could do little for medicine, as Baas laments, and the highest distinction in this field was attained by England, Italy, and Holland. The very beginning of the century (1600) is memorable for the appearance of an epoch-making work in the history of physics - the *De magnete* of William Gilbert (1540-1603).

The greatest name in 17th century medicine is that of William Harvey (1578-1657), of Folkstone in Kent, who studied at Padua as a pupil of Fabricius and Casserius, and whose work has exerted a more profound influence upon modern medicine than that of any other man save Vesalius. The world

has "heard great argument" concerning the merits and status of the De Motu Cordis, but the following facts seem irrefutable and unassailable. Harvey, who knew the whole history and literature of the subject, first made a careful review of existing theories, showing their inadequacy, and then proceeded, by experimental vivisection, ligation, and perfusion, to an inductive proof that the heart acts as a muscular force-pump in propelling the blood along, and that the blood's motion is continual, continuous, and in a cycle or circle. This was the starting-point of purely mechanical explanations of vital phenomena. The importance of Harvey's work, then, is not so much the discovery of the circulation of the blood, as its quantitative or mathematical demonstration.

Aristotle had taught that the heart is the central abode of life. Following his master, Harvey, like Descartes, revived the ancient belief of Critias that "the soul is in the blood." The doctrine of the heart as an automatic mechanism through contractile impulses passing from muscle-cell to muscle-cell, was to be the work of Gaskell and Engelmann. Harvey adhered to the old doctrine that the function of respiration was to cool the hot blood.

The discovery of the circulation itself was the most momentous event in medical history since Galen's time.

The status of Harvey's other treatise, De generatione animalium (1651), is important in the history of embryology and a matter of frequent dispute.

In his demonstration of the circulation, Harvey was brought to a standstill at one point only, viz., the capillary anastomosis between arteries and veins, which, having no microscope, he could not see. Like many experimenters, he was but an indifferent practitioner.

The 17th century was the great age of specialized anatomic research, and was notable for a long array of individual discoveries and investigations, nearly every one of which had a physiologic significance. Earliest among the achievements of the post-Vesalian anatomists was the clearing up of the old Galenical error that the veins and lymphatics of the intestines carried chyle to the liver.

This was dispelled by the discovery of the lacteal vessels in 1622 by Gasparo Aselli (1581-1626), who thought they went to the liver, the mistake being corrected by the discovery of the thoracic duct and receptaculum chyli by Jean Pecquet (1622-74). Next came the finding of the pancreatic duct in Vesling's dissecting-room at Padua by his prosector, Georg Wirsung (1642), to be followed, in order of time, by such important English discoveries as the antrum of Highmore (1651), Glisson's capsule(1654), Wharton's duct (1656), and the circle of Willis (1664). Italy won distinction in Malpighi's discovery of the capillary anastomosis in the lungs (1661), which supplied the missing link in Harvey's demonstration, and in Antonio Pacchioni's description of the so-called Pacchionian bodies (1697). Germany is memorable through Conrad Victor Schneider's classic treatise on the membranes of the

nose, Meibom's demonstration of the conjunctival glands, and Brunner's discovery of the duodenal glands; Holland by Ruysch's innovations in anatomic injecting, de Graaf's authentic account of the ovary and Graafian follicles, and Nuck's glands and ducts. Johann Conrad Peyer (1653-1712) of Switzerland, described the lymphoid follicles in the small intestine. In France, Joseph Guichard Duverney (1648-1730), professor of anatomy in Paris, made some important investigations of the inner structure of the ear which led him to write the first treatise on otology; and Raymond Vieussens (1641-1716), professor at Montpellier, made various studies on the anatomy of the nervous system (Neurologia universalis, 1685). Vieussens first correctly described the structure of the left ventricle, the course of the coronary vessels, the valve in the large coronary vein, and the centrum ovale in the brain.

As the anatomic woodcut attained its height in the Fabrica of Vesalius, so the 17th century was the great age of copperplate engraving. Anatomic illustration reached a high point of perfection in the striking plates in such works as Govert Bidloo's Anatomia (Amsterdam, 1685), Bernardino Genga's Anatomia (Rome, 1691), and the Traité de la figure humaine, of the painter Peter Paul Rubens (1577-1640). A wonderful union of scientific accuracy with artistic perfection was attained in the Tabulae anatomicae (1627) of Giulio Casserio (1561-1616), or Casserius, one of Harvey's teachers at Padua, whose "eviscerated beauties," as Dr. Holmes styled them, are as attractive

in appearance as their dissected parts were held to be instructive to the student. These Correggio-like plates of Casserius were incorporated in the atlas (1627) of Adrian van Spieghel (1578-1625), or Spigelius. For whimsical originality and exquisite delicacy of detail, the plates drawn by Frederik Ruysch (1638-1731), deserve a special mention.

A very important outcome of Harvey's demonstration of the circulation was the art of anatomic injection which was advanced by Swammerdam, de Graaf, and Ruysch.

The first crude attempt at comparative anatomy was made by Marco Aurelio Severino (1580-1656), whose Zootomia Democritae (1645) antedates Malpighi, Leeuwenhoek, and Swammerdam. A remarkable comparative anatomist of the 17th century was Edward Tyson (1650-1708). The structures in the prepuce known as Tyson's glands are named after him.

The invention of the microscope opened out a new departure for medicine in the direction of the invisible world, as Galileo's telescope had given a glimpse of the infinite vast in astronomy. The earliest of the microscopists was the learned Jesuit priest, physicist, optician, mathematician, Oreintalist, musician, and virtuoso, as well as a medical man, Athanasius Kircher (1602-80). In his Scrutinium pestis (Rome, 1658), he not only details seven experiments upon the nature of putrefaction, but found that the blood of plague patients was filled with a countless brood of "worms", not perceptible to the naked eye. Kircher's "worms" were probably nothing more than pus-cells and rouleaux of red blood-corpuscles,

since he could not possibly have seen the Bacillus Pestis with a 32-power microscope, yet it is quite within the range of possibility for him to have seen the larger microörganisms, and he was undoubtedly the first to state in explicit terms the doctrine of a contagium animatum as the cause of infectious disease. Another early worker with the microscope was Robert Hooke (1635-1703). His Micrographia (London, 1665) contains many fine plates illustrating vegetable histology. This book probably inspired the works of Nehemiah Grew (1641-1712) on vegetable histology and physiology (1671, 1682).

Jan Swammerdam (1637-80) was an expert in microscopic dissecting long before he began to study medicine. He was the first to discern and describe the red blood-corpuscles (1658), discovered the valves of the lymphatics (1664), discovered the medico legal fact that the foetus lungs will float after respiration has taken place (1667), and, in 1677, divised the method of injecting blood-vessels with wax, which was afterwards claimed by Ruysch.

A very great microscopist was Antonj van Leeuwenhoek, of Delft (1632-1723). He had some 247 microscopes with 419 lenses, most of which were ground by himself. Leeuwenhoek was the first to describe the spermatozoa; he gave the first complete account of the red blood-corpuscles (1674); discovered the striped character of voluntary muscle; was the first to see protozoa under the microscope (1675); found microörganisms in the teeth giving, for the first time, accurate figurations of bacterial chains and clumps as well as of individual spirilla and bacilli; and demonstrated

the capillary anastomosis between the arteries and veins. It was Malpighi's discovery and Leeuwenhoek's thorough work on the capillary circulation which finally completed Harvey's demonstration.

The greatest of the microscopists, however, was Marcello Malpighi (1628-94), the founder of histology, who was professor of anatomy at Bologna, Pisa, and Messina, and physician to Pope Innocent XII (1691-94). He worked on the anatomy of the silkworm and the morphology of plants, he made an epoch in medicine by his investigations of the embryology of the chick. Perhaps his greatest work is the De pulmonibus (1661). His work on the structure of the liver, spleen, and kidneys (1666) did much to advance the physiologic knowledge of these viscera, and his name has been eponymically preserved in the Malpighian bodies of the kidney and spleen. This book also contains the first account of those lymphadenomatous formations (general enlargement of lymphatics with nodules in spleen) which were fully described by Hodgkin. In personality, Malpighi was a gentle, fair-minded, sympathetic nature and, among the sick, a patient and devoted Asclepiad.

The first hard blow to the doctrine of spontaneous generation was dealt by the Italian naturalist, Francesco Redi (1626-97).

Apart from the productions of the great micrographic or morphologic botanists of the 17th century - Hooke, Grew, Malpighi - some good work was done in systematic or taxomonic botany. The English botanist, John Ray (1627-1705), separated flowering from flowerless plants in his Methodus plantarum. Augustus Rivinus (1652-1723), of Leipzig, classified the plants.

Great advances in chemistry were made by Boyle, Willis, Mayow, and others, and the period was preëminently an age of discoveries in astronomy and mathematical physics.

Following the publication of Copernicus' treatise on the revolution of the planets around the sun (1543), Galileo had invented the telescope (1609), Kepler had stated the laws governing planetary motion (1609-18), and Newton's statement of the law of gravitation (1682) was followed by the publication of his Principia (1687). Newton simultaneously with Leibnitz, created the differential calculus (1665-66), and stated the binomial theorem (1669). Von Guericke, a burgomaster of Magdeburg, invented the air-pump (1641), Torricelli, the barometer (1643) and Hooke, a compound microscope (1665).

Such important discoveries and inventions as these were not without their influence upon medicine. The Iatromathematical School, by which all physiologic happenings were treated as rigid consequences of the laws of physics, was represented by Descartes, Borelli, and Sanctorius. The protagonists of the Iatrochemical School, which regarded all vital phenomena as chemical in essence, were van Helmont, Sylvius, and Willis.

The De homine (1662) of René Descartes is usually regarded as the first European text-book on physiology. It treats of the human body as a material machine, directed by a rational soul located in the pineal gland.

Giovanni Alfonso Borelli (1608-79), a pupil of Galileo, whose De motu animalium (1680-81), at once suggests a follower of Harvey, profited much by

a long association with his colleague Malpighi. He treated locomotion, respiration, and digestion (the grinding and crushing action of the stomach) as purely mechanical processes. He originated the neurogenic theory of the heart's action, in virtue of which the heart-beat is attributed to the action of extrinsic or intrinsic nerves.

Giorgio Baglivi (1668-1706) was the first to distinguish between smooth and striped muscle (1700).

The men of the Iatromathematical School knew or cared little about the new science of chemistry, and their efforts finally dwindled away. But the effect of mathematical and experimental physics upon medicine was manifested in more important ways, notably in the first attempt to put pulse counting and clinical thermometry upon a working basis.

Between 1593 and 1597, as Weir Mitchell notes, Galileo had invented a rude thermometer or thermoscope, and as early as 1600 Kepler had used pulse counting to time his astronomic observations. Later, Galileo conceived the idea of using his own pulse to test the synchronous character of a pendulum's vibrations, which led him to the converse proposition of measuring the rate and variation of the pulse by a pendulum. Such ideas were appropriated and utilized in a remarkable way by the celebrated Paduan professor Santorio Santorio (1561-1636), called Sanctorius. In his commentary on the first book of the Canon of Avicenna (Venice, 1625), Sanctorius describes a clinical thermometer and a pulsilogium, or pulse-clock, of his own devising.

His medical fame today is best associated with the fact that he founded the physiology of metabolism through his experiments and data upon what he called the "insensible perspiration" of the body.

The physical theory of vision, which might be regarded as the basis of ophthalmology, owes its development mainly to the work of great astronomers and physicists. The Ad Vitellionem, Paralipomena, of the astronomer Kepler (Frankfort, 1604) contains a treatise on vision and the human eye in which is shown for the first time how the retina is essential to sight, the part the lens plays in refraction, and in the Dioptrica of René Descartes (1637), the eye is compared to a camera obscura. Edme Mariotte discovered the blind spot in the retina (1668).

The founder of the Iatrochemical School was the Belgian mystic, Jean Baptiste van Helmont (1577-1644). He was the first to recognize the physiologic importance of ferments and gases, and introduced the gravimetric idea in the analysis of urine.

Physiological chemistry was divested of many of the fantastic van Helmont trappings by the Leyden professor, Franciscus de la Boë, or Sylvius (1614-72). Sylvius did for Harvey's ideas what Paré had done for those of Vesalius. He regarded digestion as a chemical fermentation, and recognized the importance of the saliva and the pancreatic juice.

The leading English exponent of chemiatry was Thomas Willis (1621-75). His Cerebri Anatome (1664), in the preparation of which he was greatly in-

debted to Richard Lower and to Sir Christopher Wren, was the most complete and accurate account of the nervous system which had hitherto appeared. Willis was, like Sydenham, Heberden, and Bright, a remarkable example of the capacity of the English physicians for close, careful clinical observation. He made the best qualitative examination of the urine which was possible in his time, and was the first to notice the characteristic sweetish taste of diabetic urine. In his London Practice of Physic (1685, p.431), he described the Erb-Goldflam symptom-complex (myasthenia gravis). He was also the first to describe and name puerperal fever.

Important work in the physiology of digestion was done by the Dutchman de Graaf, and the Swiss physiologists, Peyer and Brunner.

Regner de Graaf (1641-73), of Schoonhaven, Holland, was the first to study the pancreas and its secretions before the time of Claude Bernard. De Graaf employed an artificial biliary fistula to collect the bile, in which he was preceeded, however, by Malpighi. In 1672 appeared his work on the ovary, containing the first account of the structures which Haller called, in honor of his name, the Graafian vesicles.

The name of Johann Conrad Peyer (1653-1712), of Schaffhausen, Switzerland, will always be associated with the lesions of Peyer's patches in typhoid fever.

Johann Conrad Brunner (1653-1727), of Diessenhofen, Switzerland, discovered Brunner's glands in the duodenum of dogs and man in 1672, publishing his results in 1687.

William Croone (1633-84) is memorable for two monographs on muscular physiology (1667) and embryology of the chick (1671-2).

Niels Stensen (1648-86), was a physician-priest, his name is permanently associated with the excretory duct of the parotid gland (Steno's duct). He was also one of the leading founders of geology. His treatise, <u>De solido intra solidum</u> (1669), contains, after Avicenna and Fracastorius, the most important work on the production of strata, fossils, and other geologic formations.

Francis Glisson (1597-1677), of Rampisham, Dorsetshire, was a graduate of Cambridge and Regius Professor of Physic in that University for some forty years. He wrote the original and classic account of infantile rickets, with an early note of Barlow's disease (1650); he gave the first accurate description of the capsule of the liver investing the portal vein (Glisson's capsule) and its blood-supply (1654).

The most brilliant outcome of Harvey's experimental method was in the clearing up of the obscure matter of the physiology of respiration which up to the time of Lavoisier was entirely the work of English scientists. The successive steps in what Sir Clifford Allbutt calls "the pathetic quest for oxygen" were as follows: Robert Boyle (1627-91) made experiments with flames and animals in <u>vacuo</u> (1660), demonstrating that air is necessary for life as well as for combustion. Next Robert Hooke (1635-1703), in 1667, showed, by attaching a bellows to the <u>arteria aspera</u> of a dog with opened thorax, that

artificial respiration can keep the animal alive without any movement of either chest or lungs. The next step was made by Richard Lower, of Cornwall (1631-91), an able physiologist and successful practitioner, who was the first to perform direct transfusion of blood from one animal to another (February 1665). Finally John Mayow (1643-79), another Cornishman, demonstrated, in a series of convincing experiments, that the dark venous blood is changed to bright red by taking up a certain ingredient in this air. Mayow was thus, in a sense, very close to the actual discovery of oxygen, and he fully grasped the idea that the object of breathing is simply to cause an interchange of gases between the air and the blood; and was the first to locate the seat of animal heat in the muscles.

In the latter half of the 17th century, internal medicine took an entirely new turn in the work of one of its greatest figures, Thomas Sydenham (1624-89), the reviver of the Hippocratic methods of observation and experience. His four favourite books were Hippocrates, Cicero, Bacon, and Don Quixote. His theory of medicine was simple. The human mind is limited and fallible, and to it final causes must remain inscrutable. Scientific theories are, therefore, of little value to the practitioner since, at the bedside, he must rely upon his powers of observation and his fund of experience. More than any other medical man he resembles the Father of Medicine in his mode of portraying disease and his dignified ethical regard for his patients.

Sydenham's theory of "epidemic constitutions," or <u>genius epidemicus</u>, maintains that contagious diseases are influenced by cosmic or atmospheric

influences which may change their type. Sydenham's studies in the geography and meteorology of epidemic diseases and the rhythmic periodicity of their recurrence make him, with Hippocrates and Baillou, one of the main founders of epidemiology. The clinical reputation of Sydenham rests today upon his first-hand accounts of diseases, such as the malarial fevers of his time, gout, scarlatina, measles, bronchopneumonia (peripneumonia vera), and pleuro-pneumonitis (peripneumonia notha), dysentery, chorea, and hysteria. His treatise on gout (1683) is esteemed his masterwork. He was an extensive but not an intensive blood-letter.

A famous follower and protégé of Sydenham was Walter Harris (1647-1732), of Gloucester. His treatise on acute diseases in infants (1689), remarkable for some prevision of the doctrine of acidosis, was reprinted and translated many times and held the field until the days of Underwood (1784).

A group of important monographs which deserve mention in connection with Sydenham's work comprises Tobias Cober's Observationes castrenses (1606), noting the relation between typhus fever (morbus Hungaricus) and pediculosis; the De mirabili strumas sanandi (1609) of André du Laurens, an early historic record of the King's Evil, etc. In 1614, Felix Platter (1536-1614) reported the first known case of death from hypertrophy of the thymus gland in an infant. Beriberi was first described, from East Indian cases, by the Dutch physicians, Jacob Bontius (1642) and Nicholas Tulp (1652). Bontius also described

tropical dysentery in Java. Yaws (bubas) was described by Willem Piso, in his De medicina Brasiliensi (1648) and yellow fever by Ferrara da Rosa (1694). Sir John Floyer's Treatise on Asthma (1698) gives a postmortem of pulmonary emphysema. The most important medicolegal contribution of the century was undoubtedly Swammerdam's discovery that the foetal lungs will float on water after respiration (1667). The first English book on dentistry, by Charles Allen, was printed in 1686.

Intravenous injection of drugs (1656) and transfusion of alien blood (1665-67) had their scientific origins in the 17th century.

Sir Christopher Wren (1632-1723), assisted by Boyle and Wilkins, first injected opium and crocus metallorum into the veins of dogs in 1656, which experiment was repeated by Carlo Fracassato in 1658. Priority in transfusion has been claimed for Francesco Folli (1654), but the first authenticated records are those of R. Lower (1665-67) and A. Coga (1667). Transfusion is mentioned in Pepys' Diary (November 14, 1666).

To English medicine belongs the first book on vital statistics, the Natural and Political Observations upon the Bills of Mortality (London, 1662) of John Graunt. Graunt's book was followed, in 1687, by the Essays on Political Arithmetic of Sir William Petty (1623-87). The English astronomer Edmund Halley (1656-1742) compiled the Breslau Table of births and funerals (1693) and was thus the virtual founder of vital statistics.

The mineral waters of England were studied by a goodly number of 17th

century physicians. The first London <u>Pharmacopoeia</u> was published in 1618.

The most important contribution of the 17th century to veterinary medicine was Jacques de Solleysel's demonstration of the transmission of glanders from horse to horse (1664).

In comparison with the extensive development of anatomy in the 17th century, its literature of surgery seems meager.

Among the Italians we find no surgeons commensurate in rank with those of the three centuries preceding. The only names deserving of mention are those of Cesare Magati (1579-1647), who followed Paré in holding that gun-shot wounds are not poisonous, and taught, in theory at least, the simple expectant treatment of wounds by means of bandages moistened with plain water; and Pietro de Marchetti (1589-1673). Giuseppe Zambeccari, a pupil of Redi, was a pioneer in experimental surgery.

The leading German surgeons of the period were Fabry of Hilden, Scultetus, and the famous army surgeon Purmann.

Wilhelm Fabry, of Hilden (1560-1624), called Fabricus Hildanus, is usually regarded as the "Father of German Surgery". In his monograph on gangrene (Cologne, 1593) Fabry was the first to recommend amputation above the diseased part, and is said to have been the first to amputate the thigh. He improvised a kind of tourniquet by means of a ligature tightened by a stick of wood. Fabry of Hilden was a reactionary in his use of the cautery and, like most surgeons of the day, he was a believer in the weapon-salve,

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which was applied to the weapon instead of the wound.

His contemporary, Johann Schultes (1595-1645), called Scultetus, is famous, like Albucasis and Paré before him, as one of the great illustrators of surgery and surgical instruments.

No less than 28 books on contagious diseases in armies were published in the period of the Thirty Years' War (Heizmann).

The Several Chirurgicall Treatises (1672) of the Royalist surgeon, Richard Wiseman (1622-76), is the leading work of a man who played the same part in the English surgery of his day that Sydenham did in the practice of medicine. Wiseman was a skilful operator. In his treatment on gonorrhea he mentions the first case of external urethrotomy for stricture. Stephen Bradwell's Helps in suddain accidents (1633) is the first book on first aid.

Seventeenth century obstetrics finds expression in the works of Mauriceau, de la Motte, Portal, van Deventer, Roonhuyz, and the midwife Louise Bourgeois. Of these writers, François Mauriceau (1637-1709), of Paris, is in some respects the leading representative of the obstetric knowledge of his time. His book also gives an account of the author's adventure with the celebrated Hugh Chamberlen, of the Huguenot clan who succeeded in keeping their invention of an obstetric forceps a family secret for nearly two hundred years.

Paul Portal (died 1703), of Montpellier, wrote an obstetric treatise in 1685. A far more important work is the Novum Lumen of Hendrik van

Deventer (1651-1724), which, although printed in 1701, properly belongs to the 17th century. Van Deventer, a native of Holland, has been rightly called "the father of modern midwifery." Hendrik van Roonhuyze (1625?-) was a champion of Caesarean section, and first proposed a scientific operation for vesicovaginal fistula. He is not to be confused with his son, Roger van Roonhuyze, to whom the elder Hugh Chamberlen is said to have sold the secret of his obstetric forceps about 1693.

Deaf-mute instruction was practised by the Benedictine monk Pedro Ponce de Leon (1520-84), his methods were described by Juan Pablo Bonet (1620).

Daniel Leclerc (1652-1728), of Geneva, wrote the first large history of medicine (1696).

CULTURAL AND SOCIAL ASPECTS OF 17th CENTURY MEDICINE.

The age of the rise of England and Holland was a time of spiritual and intellectual uplift. The stirring events of this age were the burning of Bruno (1600), the Thirty Years' War, the Fronde, the English Revolution, and the embarkation of the Pilgrims. With better legal regulations and restrictions, the social status of the physician was correspondingly improved, although the surgeon still was under the ban, unless needed in wartime. In Germany, the physician proper often held definite official positions, while army surgeons were called Feldscheerer because they had to shave the officers.

The condition of medicine was further improved by the ambitions of princes to found new universities, and by the introduction of two new factors of great moment, viz., the scientific society and periodic literature.

The best thinkers and scientists had long since been penetrated with the conviction that the work done in universities was valueless. The idea of scientific societies originated in Italy. The Dublin Philosophical Society was established in 1684, with Sir William Petty as first president and, after some vicissitudes, was reorganized as Trinity College in 1693. Richelieu, in France, founded the famous Académie Française at Paris in 1635. The 17th century newspaper derived from the fugitive "news-letters". The pedigree of the scientific periodical is out of the scientific society by the newspaper. The Nouvelles Découvertes sur Toutes les Parties de la Médecine of Nicolas de Blegny (Paris, 1679-81), is usually regarded as the first medical periodical in the vernacular.

The great centres of medical education in the 17th century were Leyden, Paris, and Montpellier. German medical instruction in this period was along the old mediaeval, scholastic lines, a mere blind following of Galen and the Arabians, in opposition to the folk-medicine of Paracelsus.

Botanic gardens were established at Heidelberg before 1600.

Although there were anatomic theatres in most of the continental cities in course of time, there was none in Edinburgh until 1697, after which the Scotch capital gained ascendancy under the Monro dynasty. The popularity and frequency of dissecting in Holland are sufficiently evidenced in the canvases of the great Dutch artists of the century, viz., Arend Pietersz, Thomas de Keyser, van Mierevelt, and Rembrandt.

In physics, the work of Descartes, Kepler, Sanctorius, Hooke, Borelli, and Scheiner has been mentioned; and of physician-chemists we need refer only to van Helmont, who first used the term "gas," and knew the properties of hydrogen, carbon dioxide, and sulphur dioxide; Nicolas Lémery (1645-1715), who discovered iron in the blood; and Thomas Willis, who discovered the sweetish taste of diabetic urine. Johann Rudolph Glauber (1604-88) discovered sodium sulphate (Glauber's salt), made sulphate of copper, arsenic chlorid, and zinc chlorid, distilled ammonia from bones, and obtained hydrochloric acid by distilling sulphuric acid with sea-salt. The secretive Glauber is particularly interesting because he stands between the scientific chemists, like Boyle or Mayow, and those who deliberatley followed alchemy. Alchemy became an intensive cult of extraordinary magnitude, for the philosopher's stone, otherwise known as "the quintessence" or "grand magistery," was not only supposed to transmute the baser metals into gold, make precious stones and a universal solvent, but also conferred perfect health and length of days. It was described by all who claimed to have seen it as of a reddish lustre. The doctrine of the Rosicrucians emanated from three books of mystic and alchemistic jargon, which were published during the years 1614-16. All the "six follies of science" viz., circle squaring, multiplication of the cube (fourth dimensional space or spiritualism), perpetual motion (Cornelius Drebbel), judicial astrology, alchemy, and magic were rampant in 17th century medicine.

Sir Kenelm Digby dabbled in politics, religion, and science. The sympathetic powder, his special hobby, consisted, it is said, of nothing more than green vitriol, first dissolved in water and afterwards recrystallized or calcined in the sun. Quite as amusing are the superstitions of the sympathetic or magnetic cure of wounds and the healing of disease by "stroking". Sympathetic medicine was the subject of a treatise by Sylvester Rattray (1658). The treatment consisted in anointing the weapon which had inflicted the wound with the unguentum armarium, of the patient's blood and human fat, the wound itself being wrapped in wet lint. The treatment of scrofula was, however, the special prerogative of royalty - the King's Evil, or morbus regius. Shortly before his death, in 1066, Edward the Confessor touched for scrofula in England, Henry VII, in 1462, revived the royal prerogative with an elaborate ritual. The ceremonial with the use of touchpieces and of medals as tickets of admission, were features of all subsequent reigns to the time of William of Orange, who treated the practice cavalierly; but Queen Anne revived it, even touching Dr. Johnson (without success). The exiled Stuarts "over the water" also upheld it, but it was practically discarded by George I. It was in the 17th century that the practice of the Royal Touch reached its height. Richard Wiseman, one of the ablest surgeons of the time, wrote the classic account of the King's Evil, in which he bears ample witness to the healing power of Charles II. The Royal Touch was not even subjected to ridicule

in the Pseudodoxia Epidemica; or Enquiries into Vulgar and Common Errors (1646) of Sir Thomas Browne (1605-82).

Thus while the medical science of the 17th century was making rapid strides forward, its popular medicine was already in process of retrogression to the excesses of the Byzantine Period, which bears out our main thesis, that the folk-ways of medicine are inevitably the same and independent of time and place and circumstance.

The first edition of the London Pharmacopoeia, published in 1618, contains some 1960 remedies, of which 1028 were simples, 91 animal, 271 vegetable. The Pharmacopoeia of 1650 contains cochineal, antimonial wine, the red and white mercurial precipitates, moss from the skull of a victim of violent death, and Gascoyne's powder, compounded of bezoar, amber, pearls, crabs' eyes, coral, and black tops of crabs' claws. In the Pharmacopoeia of 1677, the names of the Greeks and Arabians disappear. Old Nicholas Culpeper, the arch herbalist and quacksalver of the time, indulged in a vast amount of scurrilous raillery at the expense of the London Pharmacopoeias of 1618 and 1650, but, except for his herb-lore, he was himself only the credulous astrologer described by Nedham.

Another curious feature of 17th century therapy was the large number of private or proprietary preparations. Cinchona bark had long been known to the Peruvian Indians, and was brought to Europe by the Jesuits' in 1632. No other event, says Neuburger, did so much to upset the current school

systems of medicine as the discovery of the Jesuits' bark. Ramazzini said that cinchona did for medicine what gunpowder had done for war. Ipecac was first mentioned as igpecaya by a Portuguese friar in Purchas' Pilgrimes (1625), and brought to Paris in 1672. About 1680 it began to be extensively prescribed as a secret remedy for dysentery by Helvetius. Antimony had an extraordinary vogue during the 17th century.

Professional poisoning, as bad as that described in Livy and Cicero, was particularly rampant in Italy and France.

Apothecaries' bills were exceptionally high in the 17th century, and the cost of medicines was often exploited by physicians and surgeons as an excuse for running up their charges. The grocers were the original drug merchants, even after the apothecaries were duly incorporated by James I (1606). The long wrangle between physicians and apothecaries which came to a head in Garth's Dispensary began about the time of the Great Plague in London (1665), when the apothecaries made good in public estimation by staying at their posts, while the physicians (even Sydenham) fled for their lives. Extortion was the great failing of the apothecaries. In 1687, the College of Physicians bound their fellows and licentiates to treat the sick poor of London and its suburbs free of charge. After 1703, the English apothecaries became practitioners to all intents and purposes, and then began to make war upon those of their number who did not come up to certain standards of their own devising.

In the 17th century, the control of the trade routes and the drug marts passed into the hands of the Dutch and the English.

In the 16th century, Holland had already acquired complete control of the carrying trade between northern and southern Europe, as also of the supply of timber, tar, and wheat; but the secret of the sea route to the East Indies had been jealously guarded by the Portuguese. Torrents of blood were shed for the "apparently inoffensive clove". To get complete control of the clove, the Dutch extirpated it from the Moluccas and introduced the tree into Amboyna (Flückiger and Hanbury). To monopolize Myristica fragrans, the source of nutmegs and mace, they immersed the kernels in milk of lime for three months to prevent propagation outside the Banda Islands, and kept the entire nutmeg crop in stock at Amsterdam for sixteen years (Linton).

The purchasing power of money in the 17th century is said to have been some seven or eight times what it is now and, with this ratio in mind, we may gain some idea of the compensation and income of the physician and surgeon of the time. Harvey, who was not a successful practitioner, left an estate of £20,000. In Germany, the family physician (Hausartz) received a lump sum annually, as high as 100 marks in one case for attendance on a Bavarian countess. The pest-doctor of Prague received 2000 marks a month. The mediaeval custom of paying a life annuity for a successful operation was still in vogue. Wiseman records an annuity of £30 per annum from one patient.

The administration of military medicine during the 17th century was a continuation of the methods established at the siege of Metz (1552). In the French and English armies, regimental hospitals and company infirmaries were in fashion. In 1666, the engineer Vauban designated places for hospitals in all the captured towns fortified by him. In the armies of the Elector of Brandenburg, each regiment had a staff physician and a field barber. In 1667, Louis XIV held a conference with the surgeons Turbière, Bienaise, and Gayant on increasing the medical personnal, with the result that at the battle of Seneffe (1674), 230 army surgeons were available with nursing personnel and abundant material for the care of the wounded.

Physicians, surgeons, and barbers: The barbers continued to be a nuisance to the surgeons, and the surgeons did not succeed in getting rid of them until 1745. When, after the foundation of the College de St. Côme, the surgeon was, in a manner, assimilated to the status of the physician, he began to put on airs like the latter, wearing the square cap and long robe. By the 17th century, the physicians had become sterile pedants and coxcombs, red-heeled, long-robed, big-wigged, square-bonneted, pompous and disdainful. They were narrowly jealous of their rights and privileges, regarding their fraternity as a closed corporation, yet eternally wrangling about fantastic theories of disease and current modes of treatment. The result of all this intrigue and turmoil was that the barbers finally came into their own through the royal decree of 1660,

which unified barbers and surgeons in one guild, but otherwise reduced them to the humblest atatus. In 1686, however, an event occurred which Michelet has deemed "more important than the work of Paré". Louis XIV suffered, it seems, from a fistula in ano which, after remaining obdurate to the exhibition of all manner of ointments and embrocations, was successfully healed by operation at the hands of the royal surgeon, Félix. Louis XIV influenced French medicine in three curious ways: His attack of typhoid fever (1657) gave an immense vogue to the use of antimony; his anal fistula (1686) brought about the rehabilitation of French surgery; and the fact that his mistress was attended by Clément, the royal accoucheur, in 1663, did much to further the cause of male midwifery.

The best sidelight on the pedantic formalism and complacent ineptitude of the French internist of the period is afforded in the pensive mockery of Molière (1662-73), for example in his Le Malade Imaginaire.

In Italy, where the functions of the physician and surgeon had never been entirely separated, intensive blood-letting had continued in vogue since the days of Botallo. The costly bleeding-glasses of Venetian type were handed down in families as heirlooms. In Germany, perhaps for some temperamental reason, the degree of blood-letting seems to have been less intense, although the practice was otherwise frequent enough. The bath-keeper, plying his trade as a minor surgeon, is an index of the low status of the art in the Germanic countries, where Fabry of

Hilden was almost the only educated surgeon. The German barbers were permitted to let blood, set broken bones, treat wounds and syphilis, but were not allowed to purge. The lower strata of the profession were made up of all sorts of strolling quacks - tooth-drawers, uroscopists, magicians, rope-dancers, chiropodists, crystal gazers - who were also common in the Low Countries, and a favourite theme of the Dutch and Flemish artists. Of the many pictures of vagabond dentists, the best are the spirited canvases of the Flemish artist Theodore Rombouts in the Prado (Madrid). All these tooth-drawers have costumes evidently designed to make the bravest showing consistent with their means. The pedicurists, or corn-cutters, were a favourite subject of such men as David Teniers Jr., and Andiaen Brouwer. The strangest of the Low Country itinerants were quacks who pretended to cut stones from the head for the relief of insanity, idiocy, or other mental disorders. The most comic specimens of 17th century work in this field are the stone-drawers of Frans Hals, Jr., and Jan Steen in the Musée Boijmans (Rotterdam). Steen represents a quack incising the occipital region of a screaming fool, who is tied in a chair, while an old woman holds the pail, into which a giggling lad in the rear tosses the supposititious stones, one by one. Uroscopy is a feature of nearly all the Dutch pictures of the doctor's visit. A solemn consideration of the appearance of the patient's urine seems to have been the favourite procedure in cases of the so-called <u>minne pyn</u> or

mal d'amour, that is, the chlorosis of love-sick women. The clou is this group of paintings is undoubtedly the Mal d'Amour of Gerard Dou (Buckingham Palace).

The 17th century marks the rude beginnings of two new phases of national medicine - the Russian and the American.

Under the Romanoff dynasty (1613-45) and well into the 18th century, there was a great influx into Russia of adventurous foreigners who, through the encouragement of Peter the Great and Catherine, undoubtedly did a great deal to stimulate an interest in medicine. The first native Russian physician was Peter V. Postnikoff, who was sent to Italy to study medicine by Czar Peter and graduated at Padua in 1694. The Russian therapeutic superstitions of the time were similar to those we have found in other countries. There was the same elaborated polypharmacy, including extracts made from insects and parts of animals, and not even the critique of Ambroise Paré had dispelled the belief in the efficacy of the unicorn's horn. Under the Romanoffs a Ministry of Medical Affairs was founded, also a central store (Apteka) for the distribution of drugs to the followers of the Moscow court.

The new-world settlements of Jamestown, Virginia (1607), Plymouth Colony (1620), and the New Netherlands (1623), naturally drew to them a number of European physicians who, as in Russia, were active agents in advancing the interests of legitimate medicine in the colonies. Higher education had a definite start with the foundation and endowment of Harvard

College (1636-38).

The first hospital in the New World was erected by Cortez in the city of Mexico in 1524. In 1639 an Hôtel Dieu was established in Canada by the Duchesse d'Aguilon, and ultimately located in Quebec. The Montreal Hôtel Dieu was established in 1644, and the General Hospital of Quebec in 1693. The first hospital in what is now the United States was established on Manhattan Island in 1663.

The spirit of the 17th century was sombre and mortuary, and something of the old mediaeval feeling about Death, as the King of Terrors, survives in the gloomy forebodings of Pascal or the lines of the Jacobian dramatist, Shirley,

> "Devouring Famine, Plague, and War,
> Each able to undo mankind,
> Death's servile emissaries are."

The actual mortality from wars and epidemic diseases was as great as in the Middle Ages.

The Great Plague of London (1665) carried away 69,000; the Vienna visitation of 1679, 70,000; that of Prague (1681), 83,000; while the Italian epidemic of 1630 numbered 80,000 victims in Milan and over 500,000 in the Venetian Republic. The earliest visitations were those in Russia (1601-03), in which Moscow lost 127,000 souls from pest and famine. As in the 16th century, the local epidemics were commemorated in coins and medals, some of which were used as amulets, while others,

highly ornate, betokened the freeing of a city from the pest. Of these, we may mention the Thuringian silver pennies of 1600, 1602, and 1611; the pest-dollars (of Wittenberg type) of 1619; and the coins and medals struck off in memory of the epidemics incident to the Thirty Years' War. The comet theory of disease disappears from medical history after 1758.

State and city ordinances against the plague were many and, while providing for special hospitals, attendance, and sanitary inspection, were sometimes extremely narrow and severe. On August 25, 1683, Colbert, minister to Louis XIV, issued sanitary regulations for the whole of France, giving absolute power to the Board of Health and quarantine station at Marseilles. Not only were plague-stricken houses burned to the ground, after the Mosaic method, but persons suspected of spreading by smearing its virus about were put to torture and death.

Physicians delegated to treat the plague wore a strange prophylactic garb, consisting of a long red or black gown of smooth material (often Morocco or Cordovan leather) with leather gauntlets, leather masks having glass-covered openings for the eyes, and a long beak or snout, filled with antiseptics or fumigants, for the nose.

In "The Plague of the Philistines" by Nicolas Poussin (1593-1665) (Louvre), rats are represented in the background. Nathaniel Hodges, in his Loimologia (London, 1672), describes how, during the Great Plague of London, 1665, rodents and reptiles were seen to come out of their holes

to die in the open.

Leprosy had so completely died out by the end of the 16th century that, in 1656 and 1662, Louis XIV was able to abolish the lazar-houses and devote their endowments to charity and general hospital construction. Syphilis had also ceased to be epidemic, and was treated by mercurial fumigation and inunction at the hands of the barber-surgeons. Next to the plague, typhus and typhoid fevers, which were often vaguely described as "pest", had the highest mortality, especially in connection with the miseries engendered by the Thirty Years' War. Dysentery and scurvy also added their quota, and so great was the mortality occasioned that, according to the Excidium Germaniae (cited by Haeser), "one could wander for ten miles without seeing a soul, scarce a cow, only an occasional old man or child." Typhoid pneumonia was prevalent in Italy (1602-12). Malarial fever was pandemic in the years 1657-69 and 1677-95 (Haeser). Dysentery was epidemic throughout the countries ravaged by the Thirty Years' War, notably Germany, Holland, and France (1623-25). During the period 1583-1610, diphtheria was confined to Spain. An epidemic of anthrax (1617) is described by Athanasius Kircher in his Scrutinium pestis. There were many epidemics of ergotism. Scurvy occurred, and influenza was common throughout the century. Crookshank holds that the lethargic encephalitis at Copenhagen, the "comatose fever" of Sydenham (1673-5), and a case of encephalitis lethargica noted by J.P. Albrecht of Hildesheim (1695), were all manifestations of influenza. Yellow fever appeared at New York

in 1668, in Boston (1691-93) and Charleston, South Carolina, in 1699. Smallpox was pandemic in Europe in 1614, epidemic in England during 1666-75, while in New England, scattered outbreaks occurred all through the century. The first accounts of unmistakable scarlatina are due to Michael Doering (1625-8) and Daniel Sennert (1628). Puerperal septicemia was first defined and differentiated by Willis in 1660. Infantile mortality in this period was high. In Restoration England, sometimes half the births were obliterated by disease. In the hot summers of 1669-71, 2000 babies died of diarrhea in eight or ten weeks.

As we have seen, the 17th century, was the age <u>par excellence</u> of medical delineations in oil paintings. Velasquez devoted some twelve canvases to the representation of cretinoid or hydrocephalic dwarfs, four to court fools, and three to idiots. Of these, the Prado contains ten, including the hydrocephalic Don Sebastian de Morra. The lame, the halt, the blind, and various phases of malingering (<u>les gueux contrefaits</u>) are well represented in the etchings and engravings of Jacques Callot (1592-1635). Rubens depicted a microcephalic dwarf. Van Dyck depicted leprosy. With the exception of his "Tobias healing his father" of cataract, an etching of a leper, and a portrait of a man in the Koppel collection (Berlin), which Holländer regards as syphilitic, Rembrandt adhered rigidly to the normal.

A remarkable painting by Simon Vouet represents a case of suppurative

osteomyelitis. The Dutch paintings of scenes of medical consultations and urine inspection are, for costumes and accessories, the finest in existence. Rubens excelled all other artists in conveying the full-bodied maternal type of the later Renaissance.

THE EIGHTEENTH CENTURY:

THE AGE OF THEORIES AND SYSTEMS.

The best work of the 17th century, whether of Shakespeare, or Molière, Rembrandt or Velasquez, Spinoza or Newton, Harvey or Leeuwenhoek, was either conceived from some deep source of original inspiration or else sprang from a fresh, naïve wonderment over the newly revealed marvels of nature. It was inevitable that the period preceding the outburst of political revolution should be as a lull before an approaching tempest, but, in the end, everything tended toward formalism, and every theory, however idealistic, soon hardened into a rational, methodistic "system". Even the music of Mozart, Haydn, and Gluck seems of precise and formal cut. The best scientific work done of the period was in the fields of chemistry, mathematical physics, and invention, as witness the names of Lagrange and Laplace, Cavendish and Priestley, Scheele and Lavoisier, Galvani and Volta, Franklin and Count Rumford, Fahrenheit, Celsius, and Réaumur, Watt, Fulton, and Stephenson. For medicine, aside from the work of a few original spirits like Morgagni, Hales, the Hunters, Wolff, and Jenner, the age was essentially one of theorists and system-makers. Linnaeus established the vogue of classification in medicine

as well as in botany.

The great Swedish botanist, Carl von Linné (1707-78), or Linnaeus, was himself a physician. He originated the binomial nomenclature in science. His first work, the Systema Naturae (1735), consists of twelve folio pages containing his classification of plants, animals, and minerals. He had some notion of water-borne malarial fever and of the parasitic origin of disease.

Georg Ernst Stahl (1660-1734), of Ansbach, Bavaria, in opposition to the mechanistic physiology of Descartes, revamped van Helmont's idea of a "sensitive soul" as the source of all vital phenomena. The Stahlian "animism" (1737) is the ancient doctrine of the identity of soul and life-force (φύσις), the modern "vital principle". The body is a passive machine, permeated and guided by an immortal soul. Disease to Stahl was a disturbance of vital functions caused by misdirected activities of the soul. Like Newton, he ended his days in abject melancholia. The tendency to confuse what the poet calls "the sublime and irrefutable passion of belief" with the purposes of scientific investigation is, indeed, one of the saddest things in the history of medicine. As an advocate of psychotherapy, Stahl is a connecting link between the present and the past.

Eighteenth century vitalism assumed a specifically modern form in the Bildungstrieb of Johann Friedrich Blumenbach (1752-1840), which argues an innate impulse in living creatures toward self-development and reproduction. William Cullen (1710-90) sought to remove some of the difficulties encounter-

ed in the theory by regarding muscle as a continuation of nerve, and life itself as a function of nervous energy. Friedrich Hoffmann (1660-1742), of Halle, assumed a mysterious, ether-like fluid acting through the nervous system upon the muscles. In Allbutt's view, Hoffmann was the greatest of the iatromechanists and the first to perceive that "pathology is an aspect of physiology."

John Brown (1735-88) was a coarse man of low habits, whom Cullen had taken up and launched, but who, like Colombo, Borelli, and other ingrates of medicine, turned against his quiet teacher with the plebeian's usual tactics of reviling his intellectual betters in order to exalt himself. Brown regarded living tissues as "excitable" in lieu of the Hallerian "irritability," and life itself as non-existent, except as a resultant of the action of external stimuli upon an organized body. Diseases are then "sthenic" or "asthenic", according as the vital condition or "excitement" is increased or diminished. His Therapeutic ideas, Baas asserts, destroyed more people than the French Revolution and the Napoleonic wars combined.

The leading physician of the age was the founder of the "eclectic School", Hermann Boerhaave (1668-1738), who added to the lustre of Leyden as a medical centre, and is especially memorable through his pupils, Haller, Gaub, Cullen, Pringle, and the leaders of the "Old Vienna School," van Swieten and de Haen. Boerhaave was educated along the broadest lines, was unquestionably the greatest consultant of his time, but is now princi-

pally remembered as a great teacher and especially as an experimental chemist. His <u>Elementa chemiae</u> (Leyden, 1732), his greatest work, was easily the best book on the subject all through the 18th century. In relation to modern (non-Batavian) medicine his influence is <u>nil</u>. His writings were enormously influential in their day - his <u>Institutiones</u> (1708) and his <u>Aphorisms</u> (1709) were translated even into Arabic.

As a clinician Boerhaave stands out, like Sydenham, as a reviver of the Hippocratic method of envisaging clinical problems, which he taught at the bedside. It is said that he was the first to establish the site of pleurisy exclusively in the pleura, and to prove that smallpox is spread exclusively by contagion. He used the Fahrenheit thermometer in his clinic and the practice was kept up by his pupils, van Swieten and de Haen.

Far abler work was done by a very different group, the systematists, and we may now approach, with all due reverence, the greatest systematist after Galen, and one of the most imposing figures in all medical history, Albrecht von Haller (1708-77), the master physiologist of his time. After graduating at Leyden, having for his teachers men like Boerhaave, Albinus, Winslow, and (in mathematics) John Bernouilli, his fame as a poet and botanist soon drew him away from his native city to the newly established university at Göttingen. He was equally eminent as anatomist, physiologist, and botanist, wrote poems and historic novels. In anatomic illustration, he did much for the establishment of the norm of the blood-vessels and the

viscera. Haller distinguished between nerve impulse (sensibility) and muscular contraction (irritability). This classic research was made at Göttingen in 1757, where he also laid the foundation for his Elementa physiologiae corporis humani (Lausanne, 1759-66). To read Professor Kronecker's Haller redivivus is to see how many apparently "new" discoveries of modern observers had already been accounted for by this great master and are now forgotten. They include a reassertion of the myogenic theory (muscular autonomy) of the heart's action (1736), a recognition of the use of bile in the digestion of fats (1736), and the first experimental injections of putrid matter into the living body (1760). Akin to the French Encyclopaedists in his grasp of detail Haller was the best historian of Medicine after Guy de Chauliac.

With Haller, the systematist, we may class the works of a group of very original men, beginning with the De morbis artificium diatriba (Modena, 1700) of Bernardino Ramazzini (1633-1714), which opened up an entirely new department of modern medicine, viz., trade diseases and industrial hygiene. Ramazzini was the first after Paracelsus to call attention to such conditions as stone-mason's and miner's phthisis, the vertigo and sciatica of potters, the eye-troubles of gilders, printers, and other occupations.

"The Divine Order" (1742) of Friedrich's army chaplain, Johann Peter Süssmilch (1707-77), is an epoch-making work in the development of vital

and medical statistics. Although the English statist, John Graunt, had long before noticed (1662) that the population can be estimated from an accurate deathrate, yet the importance of Süssmilch to medical men is of a higher order than the mere casting of figures.

Here, three other famous systematists may be mentioned, viz., Johann Friedrich Blumenbach (1752-1840) of Göttingen, Pieter Camper, the founders of anthropology and craniology, and Johann Peter Frank, the founder of public hygiene. Blumenbach was followed by the learned Pieter Camper (1722-89), an artist in training, who illustrated his own works and introduced the "facial angle" as a criterion of race (1760).

A rare and happy mixture of German thoroughness with French intelligence was Johann Peter Frank (1745-1821), the four volumes of whose "Complete System of Medical Polity" are the very foundation of modern public hygiene. He was the first physician to signalize the importance of diseases of the spinal cord (1792), defined diabetes insipidus (1794), and wrote an important treatise. His great work on public hygiene left little for Pettenkofer and the moderns.

After Haller, the principal landmark of 18th century physiology is undoubtedly the Statical Essays (1731-33) of Stephen Hales (1677-1761), the originator of artificial ventilation (1743). In the first part of these essays, Hales investigates the movement of sap in plants. The second part contains his most important work, on the mechanical relations of blood-pressure. By fastening a long glass tube inside a horse's artery, Hales devised the first manometer or tonometer.

The physiology of digestion was materially advanced by the experiments of René-A.-F. de Réaumur (1683-1757) upon a pet kite. His results were very ably confirmed and extended by the work of the Abbate Lazaro Spallanzani (1729-99), of Scandiano, Italy, an investigator of singular power. Spallanzani discovered the digestive power of saliva, and reaffirmed the solvent property of the gastric juice, showing that it will act outside the body, and that it can not only prevent putrefaction, but will inhibit it when once begun. In 1768 Spallanzani founded the doctrine of the regeneration of the spinal cord. He made important investigations of the respiratory exchanges in warm and cold-blooded animals. A most important investigation of his bore upon the doctrine of spontaneous generation. Finally, Spallanzani was, with Réaumur, Trembley, and Bonnet, one of the pioneers of experimental morphology.

An English physiologist, whose work was long forgotten but has come to the front latterly on account of its essential importance, is William Hewson (1739-74), a pupil of the Hunters. Hewson afterward went into partnership with William Hunter. He made his reputation through his Royal Society memoir on the lymphatics. Present interest is centred on his <u>Experimental Inquiry into the Properties of the Blood</u> (1771). This work, a fine example of the experimental method taught by the Hunters, establishes the essential features of the coagulation of the blood in an entirely modern spirit.

William Cumberland Cruikshank (1745-1800), of Edinburgh, who succeeded

Hewson as William Hunter's assistant, gave the latter such satisfaction that he was made a partner in the Great Windmill Street School which, after Hunter's death, he took over, in conjunction with Matthew Baillie. His Anatomy of the Absorbing Vessels of the Human Body (1786) embodies the results of his labours with William Hunter. In 1797 Cruikshank demonstrated albuminuria in dropsical fevers.

While 18th-century physiology was dominated by the Glisson-Haller doctrine of irritability (muscle) and sensibility (nerve), the dominant principle of the psychology and psychiatry of the period was the animism of Stahl (1737).

Robert Whytt (1714-66), of Edinburgh, a pupil of Monro primus, Cheselden, Winslow, Boerhaave, and Albinus, is memorable as perhaps the foremost neurologist of his time. He demonstrated, for the first time, that the integrity of the spinal cord as a whole is not essential for reflex action, and was one of the first to notice the phenomena of inhibition and of spinal shock. Whytt first described tuberculous meningitis in children. His doctrine of the immanence of the soul in all parts of the nervous system was opposed by Haller.

The intervention of the soul in reflex actions was denied by Johann August Unzer (1727-99) of Halle, who first differentiated between voluntary (conscious) and involuntary movements (1746-71).

The doctrine of the life-force as the chemical expression of physiologic function was advanced by Johann Christian Reil (1759-1813), who is

memorable for his description of the "island of Reil" in the brain (1809).

In France there arose a remarkable school of physiologic (neurologic) surgeons, of whom François Pourpoir du Petit (1664-1771), made cortical phenomena basic for diagnosis in brain surgery.

Electrophysiology had its origin in the epoch-making experiments on muscle-nerve preparations, summarized in 1792 by Luigi Galvani (1737-98) of Bologna. Caldani had already experimented on electrical stimulation of the cerebral cortex (1784), but Galvani's discovery of the electric properties of excised tissues is the starting-point of modern work. It was followed up, with rare skill and insight, by Alessandro Volta (1745-1827), professor at Pavia (1778-1819), in his "Letters on Animal Electricity" (1792).

Meanwhile Benjamin Franklin, Kratzenstein (1745), Schaeffer (1752), G.F. Rössler (electric bath, 1768), Manduyt (1777), William Henly (1779), and many others were already utilizing electricity in the treatment of disease. Static machines were installed in Middlesex Hospital in 1767.

The Abbate Felice Fontana (1730-1803), author of a treatise on the venom of the viper (1767), which was the starting-point of the modern investigation of serpent venoms, experimented on stimulation of the cerebral cortex with electricity (1757) and of the central nervous system with viper venom. The most telling effect of Galvani's work was to obliterate the outworn hypotheses of activation of the nervous system by the soul, by animal spirits, or by nerve-fluid.

Perhaps the best piece of physiologic work in the 18th century was the

completion of the modern theory of respiration, which turned upon the discovery of the different gases in the atmosphere, viz., carbon dioxid by Black (1757), hydrogen by Cavendish (1766), nitrogen by Rutherford (1772), oxygen by Priestley and Scheele (1771), and Lavoisier (1775). The great Scottish chemist, Joseph Black (1728-99), is known to physicists for his original definitions of "specific heat". Joseph Priestley (1733-1804) had the truth in his grasp when he isolated oxygen (1772) and saw that vegetating plants renew vitiated air, but being a confirmed Stahlian, he only made matters worse by seeing respiration as "the phlogistication of dephlogisticated air." It was reserved for the genius of Antoine-Laurent Lavoisier (1743-94) to discover the true nature of the interchange of gases in the lungs, and to demolish the phlogiston theory by his introduction of quantitative relations in chemistry. Further, in conjunction with the astronomer Laplace (1780-85), he demonstrated that respiration is in every way the analogue of combustion. But Lavoisier had adopted the erroneous theory that the oxidation of carbon and hydrogen takes place in the tubules of the lungs. This was corrected in 1791, by Lagrange. The finishing touch was added when Gustav Magnus, in 1837, showed, with the aid of a Sprengel's air-pump, that venous and arterial blood both contain oxygen as well as CO_2.

In 1798, Thomas Beddoes (1760-1808) founded the Pneumatic Institute at Clifton for the treatment of disease by inhalation. The apparatus was

constructed by no less than James Watt, who invented the gasometre (1790), while Beddoes' assistant, Davy, discovered the anaesthetic properties of nitrous oxid (1799).

The great centre of anatomic teaching in the 17th century was Leyden; at the beginning of the 18th century, Paris. The rise of Edinburgh as a centre of medical teaching was due to the following train of circumstances: In 1700, John Monro, a Scotch army surgeon of good family, settled in Edinburgh and conceived the idea of starting a medical school in the northern capital. Three Monros, primus, secundus, and tertius, as they were called, held the chair of anatomy at Edinburgh in uninterrupted succession. The men of the Monro dynasty were, all of them, original characters of unusual attainments. It was largely due to them that Edinburgh became the great centre of medical teaching in the "last century."

Many of the best anatomists of the 18th century, such as Cheselden, Pott, the Monros, the Hunters, Desault, Scarpa, were so-called surgeon-anatomists. The surgeons Pierre Dionis and William Cheselden wrote anatomic text-books which were both of them popular in their day, but probably the best all-round treatise on the subject between Vesalius and Bichat was the Exposition anatomique (1732) of the Danish teacher, Jakob Benignus Winslow (1669-1760).

Toward the end of the century, Samuel Thomas von Soemmerring (1755-1830), a native of Thorn, Western Prussia, wrote a monumental treatise on anatomy (1791-96). He made most important researches on the brain (1799), the eye (macula lutea, 1791), the ear (1806), throat (1806), nose (1809), and hernia, but is now best remembered for his remarkable accuracy in ana-

tomic illustration and by his classification of the cranial nerves (1778). Soemmerring was also one of the inventors of the electric telegraph (1809).

A remarkable family of Prussian anatomists were the Meckels, father, son, and two grandsons.

Johann Friedrich Meckel, the elder (1724-74) graduated at Göttingen in 1748, with a noteworthy inaugural dissertation on the fifth nerve (Meckel's ganglion). He was the first to describe the submaxillary ganglion (1748). His son, Philipp Friedrich Theodor Meckel (1756-1803), was a favourite and highly honoured obstetrician at the Russian court. His son, Johann Friedrich Meckel (1781-1833) was an eminent pathologist. His most important works are his treatises on pathologic anatomy (1812-18).

The starting-point of modern embryology was the Theoria Generationis (1759) of Casper Friedrich Wolff (1733-94), of Berlin, one of the most original spirits of his time, who is eponymically remembered by his discovery of the Wolffian bodies. The younger Meckel translated his great monograph on the development of the intestines in the chick (1768-69). In 1767, from investigations of the buds of cabbages, beans, and other plants, Wolff arrived at the conclusion that "all parts of the plant except the stem are modified leaves."

This conclusion was reached independently by Johann Wolfgang von Goethe (1749-1832), one of the pioneers of evolution. Independently of Oken (1790), he stated that the skull is made up of modified vertebrae. Other forerunners of Darwin were the naturalist Buffon (1707-88), whose Histoire naturelle (1749-1804), although a popular descriptive work, con-

tained many casual denials of the fixity of species and a veiled suggestion of a possible common ancestor for horse and ass, ape and man; and Erasmus Darwin (1731-1802), whose Loves of the Plants (1789), and Zoönomia (1794) emphasized the gradual evolution of complex organisms from simple primordial forms.

Perhaps the greatest comparative anatomist of the century was Felix Vicq d'Azyr (1748-94).

The best specimens of anatomic illustration in the 18th century show the gradual passage from the copper-plate, through the taille-douce, to the steel-plate period, as seen in such splendid folios as Cheselden's Osteographia (1733), Haller's Icones anatomicae (1743-56), William Hunter's Anatomia uteri humani gravidi (1774), and the masterpieces of Haller, Santorini, Albinus, Soemmerring, and Scarpa.

The six beautiful plates of pregnancy and parturition made by Riemsdijk for Charles Nicholas Jenty (1758), of London, are rare examples of mezzotint, which was seldom used in medical illustration. Coloured copperplates were introduced in the 18th century by Jacques-Christophe Le Blon (1667-1741). Gautier d'Agoty (1717-86), a layman whose coloured mezzotints are often of striking artistic power delighted particularly in rendering the graceful physical habitus of the Parisienne of the 18th century. These pictures, originally executed life-size in oil, are, in effect, the last survivors of the skeletons, musclemen, reclining gravid women, and other stock figures of the old mediaeval MS. illustrations. Viewed simply

as oil-paintings, the life-sized Gautier panels, sold in Paris in the fall of 1914 and now in the Wellcome Museum (London), are perhaps the most remarkable examples of anatomic illustration in this medium.

One of the greatest anatomic illustrators of his time was Bernhard Siegfried Albinus (1697-1770). He was held to be an incomparable lecturer and was a master of the art of anatomic injection.

Of all medical men who have illustrated their own books, probably none have ever exhibited such striking artistic talent as that brilliant Venetian - Antonio Scarpa (1747-1832), a great anatomist and surgeon, equally skilled as orthopaedist and ophthalmologist. He himself trained Faustino Anderloni to execute the copper-engravings from his own drawings (Chouland). Executed with the force of genius, and irreproachable in accuracy of detail, Scarpa's illustrations are the crown and flower of achievement in anatomic pen-drawing. In anatomy, Scarpa is memorable for his discovery of the membraneous labyrinth, the nasopalatine nerve, and the triangle in the thigh which bears his name; he was the first to regard arteriosclerosis as a lesion of the inner coats of the arteries and, in 1832, described cubitodigital neuralgia.

The name of William Hunter is inseparably connected with the advancement of obstetrics. During the 18th century, the care of labour cases began to pass from the midwife proper to the trained male obstetrician. Peter Chamberlen attended Queen Henrietta Maria in a miscarriage in 1628. In 1692, Hugh Chamberlen delivered the future Queen Anne.

William Smellie (1697-1763), the friend and teacher of Smollett, learned his obstetrics in Paris, and settling in London in 1739, conceived the idea of teaching the subject at his own house. He acquired a large practice, and to him William Hunter came as resident pupil in 1741. Smellie introduced the steel-lock forceps in 1744, and the curved and double-curved forceps during 1751-53.

William Hunter (1718-83) had five years' training at Glasgow University, and three as a pupil of Cullen's. Following the example of his London teachers, Smellie and Douglass, he started, in 1746, a course of private lectures on dissecting, operative surgery, and bandaging. In 1768, he built the famous anatomic theatre and museum in Great Windmill Street, where the best British anatomists and surgeons of the period, including his brother John, were trained. His special discovery of the "decidua reflexa" and the separate maternal and foetal circulation, in which his brother had a part, is the foundation of modern knowledge of placental anatomy.

The obstetric treatise of the Manchester surgeon Charles White (London, 1773), stands out in its time as a pioneer in aseptic midwifery, an early brief for surgical cleanliness in obstetrics.

Operative gynaecology, as an independent specialty, had no real existence before the first half of the 19th century.

Up to the time of John Hunter, surgery was entirely in French hands, and Paris was the only place where the subject could be properly studied.

In England, Cheselden and Pott were the only two clinical surgeons of first rank before John Hunter's time. The whole period before Hunter was one of enterprise in respect of new amputations, excisions, or other improvements in operative technique, most of which are associated with French names.

Jean-Louis Petit (1674-1750), of Paris, the leading French surgeon of the early 18th century, was the inventor of the screw-tourniquet. He was the first to open the mastoid process.

Pierre-Joseph Desault (1744-95), the teacher of Bichat, was the founder of an important surgical periodical, the Journal de Chirurgie. The real originator of surgical orthopaedics was Jean-André Venel (1740-91), of Geneva, Switzerland, who in 1780 founded the first orthopaedic institute at Orbe.

Lorenz Heister (1683-1758), who made the first postmortem section of appendicitis, introduced the term "tracheotomy" (1718).

William Cheselden (1688-1752) became surgeon to St. Thomas' Hospital in 1718. He was perhaps the most rapid of all the preanaesthetic operators.

Charles White (1728-1813), of Manchester, one of the pioneers of aseptic midwifery (1773), gave the first account of "white swelling" or phlegmasia alba dolens (1784).

Percival Pott (1714-88) was surgeon at St. Bartholomew's Hospital from 1744-87. Through a fall in the street, he sustained the particular

fracture of the fibula which bears his name.

All the operators before Hunter's time were clinical surgeons, of the stamp of Paré or Richard Wisemen, and knew nothing of pathology. Even long after the publication of Morgagni's great work (1761), surgical pathology had no real existence. The first operation for localized appendicitis was reported by Mestivier in 1759.

With the advent of John Hunter (1728-93), surgery ceased to be regarded as a mere technical mode of treatment, and began to take its place as a branch of scientific medicine. After some experience as staff surgeon with the expedition to Belleisle (1761), where he gained his unique knowledge of gunshot wounds, he settled down in London to a life of ardent original investigation, diversified by extensive surgical practice and a commanding influence as a teacher. Many years after his death, his brother-in-law, Sir Everard Home, consigned himself to oblivion by burning Hunter's manuscripts after using them as the groundwork for sundry Croonian lectures and other alleged scientific contributions of his own devising. Hunter was a composite character, his work was many-sided, and we sense its magnitude not merely in his writings, many of which were destroyed, but in the great museum of over 13,000 specimens which he collected; and by the influence of such pupils as Jenner, Astley Cooper, Abernethy, Cline, Clift, Parkinson, Blizard, Home, Alanson, Wright Post, and Physick. His permanent position in science is based upon the fact that he was the founder of experimental and surgical pathology as well as a pioneer in com-

parative physiology and experimental morphology. His greatest innovation in surgery was the establishment of the principle that aneurysms due to arterial disease should be tied high up in the healthy tissues. When all is said, Hunter remains one of the great all-round biologists like Haller and Johannes Müller, and, with Paré and Lister, one of the three greatest surgeons of all time. His four masterpieces are the Natural History of the Human Teeth (1771); the Treatise on Venereal Disease (1786); the Observations on Certain Parts of the Animal Oeconomy (1786); and the Treatise on the Blood, Inflammation and Gunshot Wounds (1794).

Hunter's immediate successor in London was his devoted pupil, John Abernethy (1764-1831), who was the first to ligate the external iliac artery for aneurysm.

The surgery of the eye owes one of its most telling advancements to Jacques Daviel (1696-1762), the originator of the modern treatment of cataract by extraction of the lens (1752). An outstanding figure in the history of ophthalmology was Thomas Young (1773-1829), of Milverton, England, a Quaker physician and one of the greatest men of science of all time. In 1792, he read to the Royal Society his paper showing that visual accommodation of the eye at different distances is due to change of curvature in the crystalline lens; he gave the first description of astigmatism. He also stated the present Young-Helmholtz theory. Young was also an accomplished Egyptologist, one of the earliest decipherers of hieroglyphics.

Valentin Hauy (1745-1822) resolved to teach the blind to read, write, and play music. In 1785, he founded the Institut nationale des jeunes aveugles and began the first printing for the blind in raised characters.

The salient features of clinical medicine in the 18th century were the introduction of postmortem sections, of new methods of precision in diagnosis, and of preventive inoculation, none of which, however, were much appreciated until the following century.

Leopold Auenbrugger (1722-1809), a Styrian by birth, became physician-in-chief to the Hospital of the Holy Trinity at Vienna in 1751. His little book, Inventum Novum, is the first record of the use of immediate percussion of the chest in diagnosis. The work remained unnoticed until Corvisart took it up in 1808, one year before its author's death.

In the works of Giovanni Battista Morgagni (1682-1771), constituting the true foundation of modern pathologic anatomy, for the first time the records of postmortem findings are brought into correlation with clinical records on a grand scale.

A worthy follower of Morgagni was Matthew Baillie (1761-1823), who, like Smellie, Cullen, and the Hunters, was a native of Lanarkshire, Scotland. His Morbid Anatomy (London, 1793), differs from Morgagni's work in that it is the first attempt to treat pathology as a subject in and for itself.

In 1707, Sir John Floyer published his Physician's Pulse Watch.

The clinical thermometry dreamed of by Sanctorius, and couquetted with by Boerhaave, Haller, and de Haen, was revived in the classic Essays and Observations (1740) of George Martine (1702-41), which is the only scientific treatment of the subject before the time of Wunderlich. James Currie (1756-1805) attained eminence as a practitioner in Liverpool. Long before Brand of Stettin, Currie used cold baths in typhoid fever and checked up his results with the clinical thermometer.

One of the ablest clinicians of his time was William Withering (1741-99), of Shropshire, England, memorable as the pioneer in the correct use of digitalis. He described the epidemics of scarlatina and scarlatinal sore throat of 1771 and 1778 and, in 1793, recommended an admirable modern treatment for phthisis. In 1776, Withering learned from an old grandame in Shropshire that foxglove is good for dropsy. He immediately set about trying it in heart disease, afterward recommending its use where he could and, by 1783, it was introduced into the Edinburgh Pharmacopoeia. His views were supported by Cullen and fiercely opposed by Lettsom.

Among the English clinical teachers of the 18th century there is no name more justly and highly esteemed than that of William Cullen (1712-90). A pupil of Monro primus, he was instrumental in founding the medical school of Glasgow (1744). He was one of the first to give clinical or infirmary lectures in Great Britain, and these lectures were the first ever given in the vernacular instead of Latin (1757).

A typical practitioner of the period was the distinguished William Heberden (1710-1801). His Commentaries (1802), written in Latin, are the result of a lifetime of conscientious note-taking. They contain his original pictures of varicella (1767), angina pectoris, synthetized from 20 cases (1768), and his notation of the nodules in the fingers which occur in arthritis deformans (1802). Heberden also described "night-blindness or nyctalopia" (1767). In his Essay on Mithridatium and Theriaca (1745), he did a most important service to therapeutics by dispelling current superstitions about these curious concoctions, and banishing them forever from the pharmacopoeia.

John Fothergill (1712-80) became a very successful and wealthy London practitioner. He stands out as a true follower of Sydenham, in his Observations on the Weather and Diseases of London (1751-54), and his original descriptions of diphtheritic sore throat (1748) and facial neuralgia (1773).

John Coakley Lettsom (1744-1815) was one of the original founders of the Medical Society of London.

Caleb Hillier Parry (1755-1822) described the first recorded cases of facial hemiatrophy and of congenital idiopathic dilatation of the colon, and, in 1786, left an account of exophthalmic goitre so complete and original that it more justly entitles him to the honour of its discovery than either Flajani (1800), Graves (1835), or Basedow (1840).

John Huxham (1692-1768) won the Copley Medal for his essay on antimony (1755), and in his Essay on Fevers (1755) gave careful and original observations of many infectious diseases. He devised the familiar tincture of cinchona bark with which his name is associated. In his essay on malignant sore throat (1757), he was the first to observe the paralysis of the soft palate which attends diphtheria, and which he confused with scarlatina. In 1739, he described Devonshire colic (from cider drinking) without, however, ascertaining its true cause. This was discovered in 1767 by Sir George Baker.

Sir John Pringle (1707-82) was the founder of modern military medicine and the originator of the Red Cross idea. In his Observations on the Diseases of the Army (London, 1752), he lays down the true principles of military sanitation. He was also a pioneer of the antiseptic idea; left a good description of typhus fever; and named influenza.

James Lind (1716-94) surgeon in the Royal Navy (1739-48), was the founder of naval hygiene in England. His fame rests upon three epoch-making treatises, those on scurvy (1754), naval hygiene (1757) and tropical medicine (1768). Scurvy became an all-important subject at this time through its ravages among the sailors of Lord Anson's expedition of 1740 (75 per cent. of the total complement of men). Lind had met with 350 cases in a ten-weeks' vayage. He points out that orange and lemon juice had been employed by the Dutch (Ronssius, 1564), by Sir Richard

Hawkins (1593) and by Commodore James Lancaster (1600), after which it had been recommended in John Woodall's Surgeon's Mate. Through the powerful influence of Blane, an Admiralty order enjoining the use of lemon juice was at length issued in 1795, after which scurvy disappeared from the Navy as if by magic. In his study of jail (typhus) fever, Lind recommended all the essentials of delousing, viz., bathing, clean apparel, and baking of lice-ridden clothing in ovens. Trotter, who also wrote on scurvy (1786), says that "Lind stands alone in the Navy" as "the father of nautical medicine".

Perhaps the most important English statist of the period was John Heysham (1753-1834), of Lancaster.

The epoch-making reforms of John Howard (1726-90) in relation to the management of the prisons, hospitals, and lazarettos of Europe (1777-89) had much to do with the suppression of that vermin-carried disease, typhus fever. Howard recommended smooth floors for easy flushing, pumps, daily baths, ovens for baking clothes (virtual delousing plants), attachment of physicians and apothecaries to jails, location of suspects, and separation of the infected from susceptibles - altogether a modern programme.

There was little value in the clinical medicine of France in the 18th century. Its principal representative, Théophile de Bordeu (1722-76), the founder of the Vitalistic School of Montpellier, is now remembered as a theorist pure and simple. As Neuburger has shown, he was very

close upon the modern theory of the internal secretions and "hormonic equilibrium," but, as he made no experiments, his ideas can be regarded as sheer theory only. Bordeu's successor, Paul-Joseph Barthez (1734-1806) is memorable for his introduction of the term "vital principle". The vitalism of Bordeu and Barthez underwent a third transformation in the nineteenth century as the "semi vitalism" of Bouchut.

The rise of the Old Vienna School, under Gerhard van Swieten (1700-72), of Leyden, was a feature of the ascendancy of Austria under Maria Theresa and Joseph II. Van Swieten, who was in special favour with the Empress, did much to advance Austrian medicine. As army surgeon, he wrote an important work upon the hygiene of troops in camp. As clinician, he noted such things as the aura in hydrophobia, the occurrence of symmetric gangrene in spinal affections, and used the Fahrenheit thermometre. Besides van Swieten, the Vienna group included such prominent figures as the quarrelsome, pragmatic Anton de Haen (1704-76), of The Hague, the rabid defender of belief in witchcraft, the bureaucratic Anton Stoerck (1731-1803), the epidemiologist Maximilian Stoll (1742-87), and the dermatologist Joseph Jacob von Plenck (1732-1807).

The leading practitioners in Germany were Stahl, Hoffmann, Kämpf, Werlhof, Zimmermann, Wichmann, Senckenberg, Reil, and Heim. Of these, Paul Gottlieb Werlhof (1699-1767), was a great friend of Haller. He is now remembered by his original description of purpura haemorrhagica.

Johann Georg Zimmermann (1728-95), of Brugg, was the author of an important monograph on "Epidemic Dysentery in the Year 1765".

Johann Ernst Wichmann (1740-1802), a contemporary of Werlhof's at Hanover, is notable for his monograph on scabies (1786). Ernst Ludwig Heim (1747-1834) is said to have introduced Jennerian vaccination into Berlin in 1798.

Christian Wilhelm Huftland (1762-1836) was one of the first to espouse the cause of Jenner.

Simon-André Tissot (1728-97), the famous practitioner of Lausanne, was one of the leading propagandists of variolation (1754), wrote considerable treatises on epilepsy (1770) and nervous diseases (1782), and became widely known through his popular writings on onanism (1760).

Théodore Tronchin (1709-81), of Geneva, is notable for his compilation De colica Pictonum (1757).

The greatest Italian clinician of the period was Giovanni Maria Lancisi (1655-1720), of Rome. His great treatise on swamp fevers (1717), while stating the doctrine of miasms, shows a clear insight into the theory of contagion and the possibility of transmission by mosquitoes (Culices), of which he gives a naturalist's account.

Francesco Torti (1658-1741), professor at Modena, and a good pharmacologist, wrote an important treatise on the pernicious malarial fevers (1712), which brought about the employment of cinchona bark into Italian practice and introduced the term mal aria.

Pellagra was originally described by Gaspar Casal (1691-1759), a Spanish physician, in a book written by him in 1735, but not published until 1762. Both Casal and Thiéry called the new disease "rose sickness" (mal de la rosa). In 1771 Francesco Frapolli, an Italian physician, published a careful account of pellagra, in which he gave the malady its present name.

Connected with the history of internal medicine on the continent is the revival of Athanasius Kircher's hypnotic idea, under the guise of "animal magnetism", by Franz Anton Mesmer (1734-1815). Mesmer's graduating dissertation dealt with the subject of planetary influence on man (1771). His book containing his ideas on mesmerism, was published in 1779. Although the subject did not gain a scientific foothold until the time of Braid, mesmerism, like Lavater's ideas on physiognomy (1772), attracted a great deal of public and private notice. Somnambulism and ventriloquism began to have their vogue also, and in the "wonder-cures" of the exorcist Joseph Gassner and the necromancer Schröpfer, the magic medicine of primitive man began to loom large again.

With all its lack of instrumental precision, the internal medicine of the 18th century, as a whole, was far superior to its surgery, in that the systematic tendencies of the age led to the composition of specialized text-books, the introduction of new drugs, and the accurate description of many new forms of disease. Among these isolated clinical discoveries may be mentioned Friedrich Hoffmann's descriptions of chlorosis (1730) and

rubella (1740); Fothergill's accounts of diphtheria (1748); J.Z. Platner on the tuberculous nature of gibbous spine; Robert Hamilton on orchitis in mumps (1761); Heberden on varicella (1767); Werlhof on purpura haemorrhagica (1775); Bylon and Benjamin Rush on dengue (1779-80); Lettsom on the drug habit and alcoholosm (1786); Parry on exophthalmic goitre; George Armstrong (1771) and Hezekiah Beardsley (1788) on congenital hypertrophic stenosis of the pylorus; Soemmerring's case of achondroplasia (1791); Charles Stewart's description of paroxysmal hematuria (1794); Wollaston's discovery of urates in gouty joints (1797); and John Haslam's description of general paralysis (1798). The transmission of yaws by flies was noted by Edward Bancroft (1769). Gout and scurvy were favourite subjects of the English practitioners of the period. Of all the special monographs, the best was unquestionably the treatise of Robert Willan (1757-1812) on diseases of the skin (1796-1808).

Medical jurisprudence, which had hitherto been a part of state medicine and public health, was carefully systematized in the 18th century, and the leaders in this field were the Germans.

Medical history was systematically treated in the works of Freind (1725-27), J.H. Schulze (1728), J.C. Lettsom (1778), Blumenbach (1786), J.C.G. Ackermann (1792), and Kurt Sprengel (1792-1803). The greatest medical historian of the century was the eminent Pomeranian botanist Kurt Polykarp Sprengel (1766-1833).

In an age in which medico-historical studies were so assiduously cultivated, medical lexicography became effectively specialized. The exegesis of Greek medical terms by J.G. Hebenstreit (1751), and the lexica of Latin-French terms by Elie Col de Villars (1741) follow the old Renaissance lines. The principal medical dictionaries in English are those of John Quincy (1719), Robert James (1743), and Robert Hooper (1798). An important three-volume treatise on medical geography was published by Leonhard Ludwig Finke (1747-1828).

Toward the end of the century came one of the greatest triumphs in the history of medicine - the successful introduction of preventive inoculation by Edward Jenner (1749-1823), son of a Gloucestershire clergyman, who, in 1770, became a friend and pupil of John Hunter's, and helped him not a little in his experments. Jenner began to collect his observations in 1778 and, on May 14, 1796, performed his first vaccination upon a country boy, James Phipps, using matter from the arm of the milkmaid, Sarah Nelmes, who had contracted cow-pox in the usual way. The experiment was then put to the test, by inoculating Phipps with smallpox virus on July 1st, and the immunization proved successful. <u>An Inquiry into the Causes and Effects of the Variolae Vaccinae</u>, a thin quarto with four coloured plates, printed in 1798, was dedicated to Parry of Bath. The idea was rapidly taken up on the continent and in America; good statistics

began to pour in in less than a year's time and, by 1800, as many as 6000 people had been vaccinated. In 1802 and 1807, Parliament voted grants amounting to £20,000 to Jenner in aid of prosecuting his experiments.

Human inoculation of variolous virus is said to be mentioned in the Atharva Veda (Baas), certainly in the Flos of the School of Salerno. The idea was introduced into England by Timoni's and Pilarini's communications to the Royal Society in 1713-16, and was afterward taken up by Sir Hans Sloane (1717).

The merit of Jenner's work rests upon the fact that, like Harvey, he started out with the hope of making his thesis a permanent working principle in science, based upon experimental demonstration. His monograph of 1798 contains an early reference and a clear explanation of anaphylaxis or allergy. Like Newton, Harvey, Sydenham, Darwin and Lister, Jenner is one of the great men of purely Saxon genius, a happy combination of rare common sense with extreme simplicity of mind and character.

In Germany, Jenner's work was immediately taken up. The Berlin Vaccine Institution was founded on December 5, 1802. In the United States, the Harvard professor of medicine, Benjamin Waterhouse (1754-1846) made the first vaccinations upon his four children in July, 1800. The first Vaccine Institute was organized in Baltimore by James Smith in 1802.

There was no American medical literature to speak of until long after

the American Revolution. Some good botanic works were printed abroad. John Clayton's Flora Virginica (Leyden, 1739), was probably the first work on American botany. The first pharmacopoeia to be printed in America, a pamphlet of 32 pages, was prepared by Dr. William Brown, of Virginia, who succeeded Rush as Physician General of the Middle Department. It was designed for use in the Continental army.

The War of the Revolution was the making of medicine in America, and it was in the nature of things that it should bring to the front the three leading American physicians of the time, Morgan, Shippen, and Rush. The war found the country in a state of "unpreparedness," with nothing of military, still less of medical organization. As Mumford says, there was but one man who was found "steadfast, patient, imperturbable," and that was Washington. All honour to his two Surgeons General, Morgan and Shippen, who did so much for the organization of American medical education. Benjamin Church was the first Surgeon General of the American Army.

John Morgan (1735-89), a native of Philadelphia, served as surgeon in the French wars, and graduated at Edinburgh in 1762, where he was trained by such masters as William Hunter, the Monros, Cullen, and Whytt. Returning to his native city in 1765, he published, in the same year, his Discourse upon the Institution of Medical Schools in America. In 1775, Congress appointed Morgan "Director General and Physician in Chief" of the American Army, to succeed Church, but the enmity of his subalterns

and the shiftiness of politicians led to his unjust dismissal by Congress in 1777, and Shippen was appointed in his place.

William Shippen, Jr. (1736-1808), of Philadelphia, who succeeded Morgan as Surgeon General in 1777, was also an Edinburgh graduate. In 1762 he began to give private and public instruction in anatomy and obstetrics, and was, indeed, the first public teacher of obstetrics in the country. In 1765, he collaborated with Morgan in organizing the Medical Department of the University of Pennsylvania.

Benjamin Rush (1745-1813), of Pennsylvania, was of English Quaker stock and a graduate of Princeton (1760) and Edinburgh (1768). In 1769, he was elected professor of chemistry in the College of Philadelphia, and succeeded Morgan as professor of practice in the same institution in 1789, attaining the chair of institutes of medicine, when the latter was merged into the University of Pennsylvania in 1791. He was also physician to the Pennsylvania Hospital (1783-1813). Rush was easily the ablest American clinician of his time. He belongs to the school of Sydenham in his adherence to blood-letting and in his careful accounts of the diseases under his observation. He described cholera infantum in 1773, and was the first, after Bylon of Java (1779), to describe dengue (1780). His monograph on insanity (1812) was pronounced by Mills to be, with that of Isaac Ray, the only systematic American treatise on the subject before the year 1883. His account of the Philadelphia epidemic of yellow fever

(1793) is only approached by that of Matthew Carey for its realism.

The name of Benjamin Franklin (1706-90), of Boston, is intimately connected with American medicine through his invention of bifocal lenses (1784), a flexible catheter and a stove, his letters on the treatment of paralysis by electricity (Franklinism, 1757), and on lead-poisoning (1786), and his observations on gout. He was the principal founder and the first president of the Pennsylvania Hospital (1751).

Thomas Cadwalader (1708-79), of Philadelphia, a pupil of Cheselden, was a pioneer of inoculation (1730), and the first to teach anatomy by dissections in the city (1730-31).

CULTURAL AND SOCIAL ASPECTS OF EIGHTEENTH CENTURY MEDICINE

The tendencies of the age were artificial and theoretic rather than sincere or realistic. This periwigged period is conceded to have been the "Golden Age," alike of the successful practitioner and the successful quack. Haller, William Hunter, Scarpa, Heberden, and Thomas Young yield to none in scholarship. In England, the fashionable physician wore a powdered wig, a handsome coat of red satin, or brocade, short breeches, stockings and buckled shoes, a three-cornered hat, and bore a goldenheaded cane.

Except in caricature, the art of the 18th century throws but little light upon the status of the medical profession. A few portraits of physicians were painted by Raeburn and others, with Sir Joshua's great portrait of John Hunter at the head of the list.

Hogarth's "Company of Undertakers" (1736) portrays quacks of the period. He also made two pictures of Maria Toft's miraculous birth of rabbits.

In the secular literature of the 18th century the physician was especially satirized by Smollett (Count Fathom), Sterne (Dr. Slop), and Le Sage (Gil Blas). Le Sage throws much light upon medicine in Spain, where blood-letting and cathartics were almost the only known remedies, where cleaning the streets of offal was opposed for a fantastic reason, where there was not a single apothecary for over half a century. It was the age par excellence of successful quacks.

Quackery, if not universal, was at least, in Thoreau's phrase, "universally successful." There was a long line of successful medical charlatans of both sexes. The earliest of these was Sir William Read, who started out as a tailor, subsequently becoming oculist to George I. Other quack oculists were Dr. Grant, Thomas Woolhouse (oculist to James II and William III) who is said to have proposed iridectomy in 1711, and the Chevalier Taylor. Daviel was really a great ophthalmic surgeon in the making, where Taylor was only a clever buffoon. The Ward to whom Dr. Johnson refers was Joshua Ward, another famous quack.

Notable female impostors of the period were Mrs. Mapp, and Joanna Stevens, who, in 1739, actually succeeded in having her remedy for stone purchased pro bono publico by Act of Parliament. The recipe was published

in the London Gazette of June 19, 1739, and turned out to be a set of mixtures of egg-shells, garden-snails, swines' cresses, soap, and such vegetable ingredients as burdock seeds, hips, and haws. In each one of her certified "cures", the stone was found in the bladder after death.

Among the therapeutic fads of the time were quassia-cups, saffron drops, purging sugar-plums, anodyne necklaces for pregnant women and teething children, Macassar oil (for the hair), and the metallic or magnetic tractors patented by Elisha Perkins of Connecticut in 1798. Cures were affected by stroking, and their principle of action was supposed to be analogous to that of galvanism or animal magnetism. Electricity and animal magnetism were exploited as a special mode of appealing to the baser passions by James Graham of Edinburgh, who was the coryphaeus of "celestial beds" for rejuvenating senility. More respectable, and hardly to be classed among out-and-out quacks, were the "Whitworth doctors," otherwise the Taylor brothers..

The professional jealousy and rancour which obtained among some members of the profession can be sensed in the virulent character of their medical controversies. On the evening of June 10, 1719, in the quadrangle of Gresham College, Richard Mead and John Woodward began a duel with swords about their views on the treatment of smallpox. The general tendency of the age was toward sobriety, urbanity, extremely artificial manners, and the control of the body by the mind. Of the

fashionable London practitioners of the period Sir Samuel Garth (1661-1719) was the only physician who belonged to the famous Kit-Kat Club. John Arbuthnot (1667-1735) was the friend and familiar of Pope and Swift. Sir Richard Blackmore, although a total failure as a poet, was accounted one of the most successful men in the medical profession. Sir Hans Sloane (1660-1753), the first physician to be made a baronet, enjoyed the highest scientific and professional reputation, was a founder and later the secretary and president of the Royal Society. His museum and library, after his death, became the nucleus of the present British Museum collections. John Radcliffe (1650-1714) was a Jacobite, and "contrived by his shrewd humour, arrogant simplicity, and immeasurable insolence to hold both Whigs and Tories in his grasp". He left funds to Oxford for the present foundations known as the Radcliffe Library, the Radcliffe Infirmary, etc. Toward the close of his life, he took a fancy to young Richard Mead (1673-1754), who flattered his vanity and so inherited his practice. Mead was a complete contrast to his predecessor - a scholar, courtly and polished. After him came such men as Heberden, Lettsom, Fothergill, Parry, and the Hunters.

On the continent we find Werlhof, court physician at Hannover; in Halle, Stahl and Hoffmann, and later Reil; in Berlin, Heim; in Jena, Hufeland; in Vienna, van Swieten and de Haën; in Paris, Théophile de Bordeu; in Modena, Torti; at Pavia, Borsieri de Kanilfeld and Peter

Frank; in Geneva, Tronchin; and at Lausanne, Tissot.

The Chimney Sweeper's Act of 1788 was motivated by Pott's account of chimney sweep's (scrotal) cancer (1775), which set forth the misery and virtual slavery of the poor "climbing boys."

In 1792, Benjamin Thomson, Count Rumford (1753-1814), of Woburn, Mass., established the People's Soup Kitchens at Munich, with provision for warm meals for school children, the first venture of this kind.

Another side-light on the social status of 18th century physicians is afforded by the incomes they made and the fees some of them received. The phenomenal fee of the period was that acquired by Thomas Dimsdale for inoculating Catherine of Russia and her son, viz., $50,000, with $10,000 additional for travelling expenses, a pension of $2500 for life, and the rank of baron of the empire.

Three new editions of the London Pharmacopoeia were issued during the 18th century, each of them characterized by changes which show the status of therapeutics and the gradual advance of pharmacology. The fourth Pharmacopoeia (1721), edited by Sir Hans Sloane, drops many of the old syrups and waters, but retains theriac, extracts of excreta and other animal products. In the sixth Pharmacopoeia (1788) practically all the animal materia medica has disappeared, along with theriac and mithridate. Dover's powder was introduced by the famous buccaneer physician, Thomas Dover (1660-1742). Thomas Fowler introduced his solution of arsenic in 1786. Many physicians of the 18th century, including

Hoffmann, Stahl, Sloane, and Mead, made money by selling preparations with secret formulas. That English clergymen dabbled in therapeutics is plain from the lucubrations of Bishop Berkeley on the virtues of tar-water (1720-48) and John Wesley's Primitive Physick (1747).

Except in France, the status of surgery was exceedingly low during the greater part of the 18th century. The French surgeon owed the improvement in his social condition to the fistula of Louis XIV and its successful treatment by Félix. The ordinance of Louis XV (1743), delivered the surgeons from further association with barbers and wig-makers, who were forbidden to practise, while no one could be a master in surgery thereafter without being a master of the arts.

During the French Revolution, the 18 medical faculties and 15 medical colleges of France were abolished by vote in 1792. This was modified in 1794, by the creation of Écoles de santé, the title of "health officer" (officier de santé) being substituted for that of "doctor". The Écoles de santé were created to supply the urgent need for military surgeons for the armies of the Republic, so that the schools at Paris, Montpellier, and Strassburg were, in reality, schools of military medicine.

In 18th century England, there were no surgeons of first rank before the time of Pott and Cheselden, Hunter and Abernethy. On June 24, 1745, through the good offices of Mr. Ranby, serjeant surgeon to the king, the surgeons were formally separated from the barbers as the "Masters, Gover-

nors, and Commonalty of the Art and the Science of Surgeons of London." In 1800, the Corporation of Surgeons was rechartered by George III as the Royal College of Surgeons of London and, in 1843, this body became the present Royal College of Surgeons of England. The London Hospital began to take in students in 1742, and was fully organized by 1785. The only Edinburgh surgeons of prominence were Benjamin Bell, and John Bell whose unfortunate passion for controversy kept him out of the Royal Infirmary.

In Germany, there was little advancement of the surgeons' status before the time of Frederick the Great. Haller lectured and wrote on the subject without having performed an operation in his life, and there was no adequate teaching, until Richter began to lecture at Göttingen (in 1766) and von Siebold at Würzburg (in 1769). Surgical practice was mainly in the hands of the barber, the executioner, and the strolling bone-setters, cataract-couchers, herniotomists and lithotomists, of whom the famous Dr. Eisenbart was the type. Superstitious belief in charms and magic prevailed. The Prussian Army surgeon of the day was ranked above a drummer and beneath a chaplain, he had to shave the officers.

In Russia, Peter the Great, who visited Boerhaave and Ruysch, tried to nationalize medicine, and to this end built the first hospital and medical school in Russia (copied from the Greenwich Hospital) in 1707.

The administration of military medicine became, in the 18th century

a function of government.

Many new scientific and medical societies were founded. Of medical libraries, Lancisi founded the Biblioteca Lancisiana at Rome (1711) and, in 1733, the Faculty of Medicine of Paris, which possessed only 32 books, acquired from François Picoté de Bélestre some 2273 volumes, the nucleus of its present splendid collection, the largest in the modern world. Similar collections by Sir Hans Sloane and John Radcliffe were the origins of the Library of the British Museum and of the Radcliffe Camera at Oxford. The earliest medical periodicals of the 18th century were the _Weekelijk Discours de Pest_ (Amsterdam, 1721-22), _Esculapius_ (Amsterdam, 1723), _Der patriotische Medicus_ (Hamburg, 1724-26), followed by many others.

Advancement of medical education was mainly effected in anatomy and clinical medicine. Before the advent of John Hunter, surgery was well taught at Paris only; prior to the Monro dynasty, anatomy flourished principally on the continent. In Great Britain, chairs of anatomy were established at Edinburgh (1705), Cambridge (1707), Glasgow (1718), Oxford ("lecturer on anatomy," 1762), and Dublin (1785). The first professor of the subject was Robert Elliot, who assumed his Edinburgh chair in 1705, at an annual salary of £15, and resigned in favour of Monro _primus_ in 1720. John Bell gives some grim details of bungling, incompetent surgery as a result of anatomic ignorance. In Italy, before the time of Scarpa, Felice Fontana's wax preparations were used in lieu of cadavers

for teaching purposes.

With such a great leader as Linnaeus, it was natural that botany should have been extensively cultivated in this period. Kew Gardens was established as a royal preserve about 1730.

Except at Leyden, there was no clinical instruction on the continent until 1745, when an ambulatory clinic was established at Prague, which lasted about one year. In 1745, van Swieten organized a clinic at Vienna. About 1757, Cullen began to lecture on medicine in English instead of Latin. The special feature of modern English clinical instruction, the hospital medical school, had its beginnings in such institutions as Guy's Hospital (1723), the Edinburgh Hospital (1736), or the Meath Hospital (Dublin, 1756), and attained a definite status at the London Hospital Medical School (1785), and at St. Bartholomew's under Abernethy (1790). The private medical school of Sir William Blizard and Maclaurin became, in 1785, the London Hospital Medical School. On June 14, 1710, the School of Physic in Trinity College, Dublin, was founded.

Many new hospitals were built in the 18th century, but, in respect of cleanliness and administration, these institutions sank to the lowest level known in the history of medicine. The Royal Sea-Bathing Infirmary for Scrofula, a new departure in the treatment of surgical tuberculosis, was opened at Margate in 1791.

In 1788, Jacobus-René Tenon published a series of memoirs on the

hospitals of Paris, containing his famous description of the old Hôtel Dieu, which was at that time a veritable hotbed of disease. Acute contagious diseases were often in close relation to mild cases, vermin and filth abounded. Septic fevers and other infections were the rule. The same thing was true of the Allgemeines Krankenhaus of Vienna, the Moscow Hospital, and many other institutions of size, and it was not until John Howard had made his exhaustive studies of the condition of European hospitals, prisons, and lazarettos (1777-89), and after Tenon had published his report (1788), that any attempts at reforms were made. But hospitals remained notorious for uncleanliness and general danger to life well into the 19th century. The real angel of purity and cleanliness was Florence Nightingale, and there was no such thing as surgical cleanliness before the time of Lister.

Bad as was the management of hospitals, the treatment of the insane was even worse. Until well into the 19th century, insanity was regarded not only as incurable, but as a disgrace rather than a misfortune. Insanity was still attributed to yellow and black bile or to heat in the dog days. The cases treated were all of the dangerous, unmanageable, or suicidal type, and no hope of recovery was held out. Marriage was recommended as a cure.

The Quaker retreat, founded by William Tuke in 1794 at York, England, was the first attempt at humane treatment of the insane before the advent

of Philippe Pinel (1745-1826), who, on May 24, 1798, with the consent of the National Assembly, struck off the chains from 49 insane patients at Bicêtre, as depicted in the painting of Tony-Robert Fleury.

In Emile (1762), Jean-Jacques Rousseau made his famous protest against the disinclination of French mothers to nurse their own children. At this time, the rate of infantile mortality was appalling. Of 31,951 children admitted to the Paris Foundling Hospital during 1771-77, 25,476 (80 per cent.) died before completing the first year. At the Dublin Foundling Asylum, during 1775-96, only 45 survived out of 10,272 (99.6 per cent. mortality). Sir Hans Sloane stated that the ratio of mortality of dry-nursed to breast-fed infants was as three to one. The hired wet-nurse had her palmiest period at the end of the 18th century. With clear insight, Michael Underwood (1784) recommended boiled cow's milk diluted with barley-water. Thus artificial infant feeding had its origin in the 18th century. The original sucking-bottle was a cow's horn, already known in 1783, and highly recommended by Heberden. This was followed by the glass bottle, the pap-boat, and the pap-spoon. The nipple was made successively of parchment and leather, sponge, heifer's teats kept in spirit, wood and india-rubber.

Outbreaks of epidemic diseases were more scattered and isolated than in former centuries. Malarial fever, influenza, and scarlatina were often pandemic; smallpox, diphtheria, and whooping-cough were widely

diffused, but plague, syphilis, ergotism were far less malignant. At the beginning of the century, the principal focus of the plague was in Turkey and the Danube region; by 1703, it was devastating the Ukraine, whence, through the war of Charles XII with Russia, it gradually spread to the Baltic Sea and the Scandinavian countries. Danzig sustained a mortality of 32,5999 (January 5 to December 7, 1709). In England, Richard Mead's Discourse on the plague (1720) effected the humane sanitary reform of isolating plague patients outside the city limits, instead of incarcerating them in their own houses. Typhus or camp fever was, of course, especially prevalent during all the wars of the century, and, as "famine fever", in Ireland. Jail fever was again rife at the Black Assize at the Old Bailey (London) in 1750, carrying off the Lord Mayor, 3 judges, 8 of the Middlesex jury and over 40 others, all on the left side of the court-room. At the instance of Stephen Hales and Pringle, the Corporation of London tried to ventilate Newgate Prison and to remove the distemper, but without avail. Lind, from experiences on board ship, stated that ventilation would not stop fail fever. He recommended such modern delousing procedures as stripping, bathing, and baking infestated clothing in ovens. In 1774, on recommendation of John Howard, Alexander Popham (1729-1810), M.P. for Taunton, introduced his celebrated bill for the prevention of gaol distemper. The old window-tax of March 25, 1696

(7. and 81 William and Mary, Cap, 18) was pushed to an exorbitant extreme in 1746-7. In France, the window-tax and the salt-tax (gabelle) were among the many sources of discontent which led to the Revolution. Remarkable work was done by such pioneer epidemiologists as Haygarth at Chester (1772-81), Percival (1772-6) and Ferrar (1790-1804) at Manchester, and Lettsom in London (1773-1808). Typhus and typhoid fevers were, of course, confused. Huxham, during the Plymouth epidemic of 1737, clearly distinguished between "putrid" (febris putrida) or typhus, and "slow nervous fever" (febris nervosa lenta) or typhoid fever. Malarial fever was spread by inundations, pollution of streams, and the unsanitary condition of streets and sewers. Dysentery was prevalent on the continent throughout the century. The term "puerperal fever" was introduced by Edward Strother. Scarlatina was still confused with measles. There were several pandemics of influenza in both the old world and the new. Diphtheria, yellow fever, whooping-cough, and epidemic pneumonia were widespread; croup and erysipelas were occasionally epidemic. Small-pox was so common everywhere that it was taken for granted. The great success of Jennerian vaccination has obscured the early history of the other preventive measure which it eventually displaced, inoculation of human virus or variolation. The practice was introduced into Europe by Emanuel Timoni and Pilarini, who published accounts of it in 1713 and 1716, respectively. The subsequent success of Jenner's experiments soon swept

variolation from the field. In England, variolation was declared a felony by Act of Parliament in 1840.

Until after the Revolution, there was little advancement in the status of American medicine.

Before 1700, there were five good medical schools. The first medical diploma to be awarded after a course of study in America was given to John Archer at the University of Pennsylvania in 1768. Medical societies were organized in Boston (1735-41), New York City, etc. Medical periodicals of the period were the Medical Respository of New York (1797-1824), edited by Samuel L. Mitchill, Elihu H. Smith, and Edward Miller; a single number of a translation of the Journal de médecine militaire of Paris (1790), and John Redman Coxe's Philadelphia Medical Museum (1804). The hospitals of the early period were the Pennsylvania Hospital of Philadelphia, organized in 1751, the New York Dispensary (organized 1791), and the New York Hospital. Medical libraries were founded in the Pennsylvania Hospital (1762), the New York Hospital (1776), and the College of Physicians of Philadelphia (1788). The favourite text-books of the period were Albinus, Cowper, Cheselden, Monro, and Winslow in anatomy, Haller's First Lines of Physiology, Boerhaave and van Swieten on internal medicine, Heister's surgery, Smellie's midwifery, and, of course, Sydenham, Pott, Huxham, and other well-known authors. Obstetric cases were usually handled by midwives. The first male obstetricians were pupils of Smellie, and William Hunter.

THE NINETEENTH CENTURY:

THE BEGINNINGS OF ORGANIZED ADVANCEMENT OF SCIENCE.

In the evolution of modern medicine, as in the development of pure science of which it was a part, three factors seem of especial moment. First of all, the great industrial or social-democratic movement of civilized mankind, which, following close upon the political revolutions in America and France, intensified the feeling for intellectual and moral liberty and upheld the new idea of the dignity and importance of all kinds of human labour. Some immediate corollaries of this proposition were the removal of the civil disabilities oppressing the Jews. Second, the publication of such works as Helmholtz's Conservation of Energy (1847) and Darwin's Origin of Species (1859). Third, as an inevitable consequence, physics, chemistry, and biology came to be studied as objective laboratory sciences. Medicine owes much to the great mathematicians and physicists of the 17th and 18th centuries, who developed the theory of vision and almost the whole physiology of respiration.

The physical principle of Conservation of Energy was demonstrated by Robert Mayer (a physician of Heilbronn) and James Prescot Joule in 1842, and applied to the whole field of chemistry and physics by Helm-

holtz in 1847. The principle of Dissipation of Energy was first stated by Sadi Carnot (1824), developed by Clausius (1850) and Lord Kelvin (1852), and applied to all physical and chemical phenomena by the Yale professor, Willard Gibbs (1872-78).

In 1859, Kirchhoff and Bunsen devised spectrum analysis. Faraday (1821-54) and Maxwell (1865) worked out the whole theory of electricity and electromagnetism, upon which followed such practical consequences as electric lighting, heating, and motor power, telephonic communication, and the realization of wireless telegraphy (radio) by Hertz (1887) and Marconi (1895). The Roentgen rays were discovered in 1895. The Curies isolated radium chloride in 1898. John Dalton stated the chemical law of multiple proportions (1802) and the atomic theory (1803); Wollaston showed that gas explosions will not pass through a small tube (1814), which led to Sir Humphry Davy's safety lamp (1815); and invented the camera lucida (1807); Helmholtz invented the ophthalmoscope and the ophthalmometer (1850); and William Charles Wells (1757-1817) developed the theory of dew and dewpoint (1814). Photography was developed by Niepce (1814), Daguerre (1839), Draper (1840), and Fox Talbot (1840). Joseph Jackson Lister (1830) devised the improved achromatic lenses of the compound microscope, Chevalier the compound objective, and E. Abbé the modern illuminating apparatus.

It will be seen, from the dates of these discoveries, that the modern scientific movement did not attain its full stride until well after the

middle of the century. The medicine of the early half was, with a few noble exceptions, only part and parcel of the stationary theorizing of the preceding age. Up to the year 1850 and well beyond it, most of the advancements in medicine were made by the French. After the publication of Virchow's "Cellular Pathology" (1858), German medicine began to gain its ascendancy. The discoveries of anaesthesia (1847) and antiseptic surgery (1867), were the special achievements of the Anglo-Saxon race.

On the continent of Europe, Immanuel Kant, who pointed out the limitations of thought and the subjective character of human observation, had little effect upon medical theories, but the so-called "Nature Philosophy" of Schelling, which aimed to establish the subjective and objective identity of all things, and the system of Hegel, which, like evolution today, regarded everything as in a state of becoming something else (Werden), exerted a very baneful effect upon German medicine by diverting mental activity away from the investigation of concrete facts into the realm of fanciful speculation.

François-Joseph-Victor Broussais (1772-1838) served for three years as an army surgeon in Napoleon's campaigns. He modified the Brunonian theory by saying that life depends upon irritation. The only merit in his reasoning was that he substituted the diseased organ for the hazy concept "fever". He adopted a powerful antiphlogistic or weakening régime, the main features of which were to deprive the patient of his pro-

per food and to leech him all over his body. His extravagances were finally exploded by the good sense and temperate judgment of the clinician Chomel, the statistical inductions of his pupil Louis and the sarcasms of Laennec, who slyly likened Broussais to Paracelsus.

The arbitrary doctrines of Broussais were finally overthrown by Pierre-Charles-Alexandre Louis (1787-1872), the founder of medical, as distinguished from vital, statistics. He thought that statistics can sometimes be used as an instrument of precision in cases where proper experimental methods are wanting. The value of his idea was shown by Fournier and Erb in demonstrating the causal nexus between tabes, paresis, and syphilis; and by others, in testing the value of hydrotherapy in typhoid, of antitoxin in diphtheria, or in trying out new drugs.

The most distinguished and important internist of the early French school was Réné-Théophile-Hyacinthe Laennec (1781-1826), a native of Quimper (Brittany), who, like Bichat, was a regimental surgeon in the Revolution, and was also, like him, an early victim of phthisis. He made his name immortal by his invention of the stethoscope in 1819 (at first only a cylinder of paper in his hands), and by the publication of the two successive editions of his <u>Traité de l'auscultation médiate</u> in 1819 and 1826. This work placed its author among the greatest clinicians of all ages, and had better luck than Auenbrugger's, for it was immedi-

ately taken up and translated everywhere. Laennec not only put the diagnostic sounds of cardiac and pulmonary disease upon a reliable basis, but was the first to describe and differentiate bronchiectasis, pneumothorax, haemorrhagic pleurisy, pulmonary gangrene, infarct and emphysema. He established the etiologic unity of tubercle and has been defined as "the greatest of teachers on pulmonary tuberculosis."

Pierre Bretonneau (1771-1862) wrote important monographs on the contagion of "dothienenteritis" or typhoid fever (1819-29), on diphtheria (1826), and, on July 1, 1825, performed the first successful tracheotomy in croup. He located and understood the typhoid lesions in Peyer's patches, predicted that typhoid would some day be differentiated from typhus, and, in 1855, clearly stated the doctrine of specificity (germ-theory) in disease.

Jean-Baptiste Bouillaud (1796-1881) although a furious blood-letter, was one of the ablest diagnosticians of his time. He was the first to point out that aphasia is correlated with a lesion in the anterior lobes of the brain (1825) and he established a "law of coincidence" between the occurrence of heart disease and acute articular rheumatism (1836).

Jean-Nicolas Corvisart (1755-1821), Napoleon's favourite physician, and the teacher of Bayle, Bretonneau, Dupuytren, Laennec, and Cuvier, is now remembered chiefly through his revival of Auenbrugger's work on percussion.

The noble-minded Philippe Pinel (1745-1826), of Saint-Paul (Tarn), stands high in medical history as the first to treat the insane in a humane manner.

Pierre-Adolphe Piorry (1794-1879), of Poitiers, was the inventor of the pleximeter (1826) and the pioneer of mediate percussion.

Pierre-François-Olive Rayer (1793-1867) wrote a treatise on skin diseases, with atlas (1826-27), which succeeded Biett. He first described adenoma sebaceum.

Philippe Ricord (1799-1889), born of French parents in Baltimore, Md., and a graduate of the Paris Faculty, was the greatest authority on venereal diseases after John Hunter. His treatise on the subject is memorable in the history of medicine for overthrowing Hunter's erroneous ideas as to the identity of gonorrhea and syphilis.

Modern dermatology derives from the work of Willan, and his pupil Bateman. Robert Willan (1757-1812) did much to clear up the nature of eczema and lupus. His great work <u>On Cutaneous Diseases</u> (1796-1808), published in parts, was left unfinished at his death, and was completed by Bateman.

The founder of the modern French school of dermatology was Jean-Louis Alibert (1768-1837). He was the first to describe mycosis fungoides, and, as <u>pustule d'Alep</u> (1829), the endemic ulcer now correlated with the Leishman-Donovan bodies.

Laennec's teaching had an immediate outcome in Great Britain in the brilliant clinical work of two physicians of the Irish school. The founders of the Dublin school were John Cheyne (1777-1836), who described acute hydrocephalus (1808) and Cheyne-Stokes respiration; Abraham Colles (1773-1843), who stated "Colles' law"; and Robert Adams (1791-1875), who left classic accounts of essential heart-block (1826) and rheumatic gout (1857). The true leaders of the Dublin school, however, were Graves and Stokes.

Robert James Graves (1796-1853), the son of a Dublin clergyman, became chief physician to the Meath Hospital. Here he immediately went in for the widest reforms, introducing the continental methods of clinical teaching. His Clinical Lectures (1848), which Trousseau read and re-read with highest admiration, introduced many novelties, such as the "pin-hole pupil". He also left early accounts of angioneurotic edema, scleroderma and erythromelalgia. In 1835, he published a description of exophthalmic goitre so admirable that the disease still goes by his name.

William Stokes (1804-78), Graves' colleague at Meath Hospital, put himself on record as a disciple of Laennec by the publication of his "Introduction to the Use of the Stethoscope". He reported the first case of cholera in the Dublin epidemic of 1832, and, in 1846, published his celebrated accounts of Cheyne-Stokes breathing and the Stokes-Adams disease.

Sir Dominic John Corrigan (1802-80) published an original description of insufficiency of the aortic valve. He was the first to throw into relief the characteristic receding or "waterhammer" pulse in aortic regurgitation (Corrigan's pulse). He also noted the "cerebral breathing" of typhus.

The English clinicians of the early 19th century assimilated the ideas of Laennec and Bichat in their practice. Of special importance is the clinical and pathologic work which was done by the long line of brilliant workers at Guy's Hospital. Of these, Richard Bright (1789-1858) was for twenty-three years (1820-43) physician at Guy's where he worked for six hours a day in the wards and postmortem room. He was the leading consultant of London in his day. His Reports of Medical Cases (1827), containing his original description of essential nephritis, with its epoch-making distinction between cardiac and renal dropsy, at once established his reputation all over Europe. Saliceto, the Italian surgeon, had pointed out the association of dropsy, scanty urine, and hardened kidneys (durities in renibus) in 1476. Bright left original accounts of pancreatic diabetes and pancreatic steatorrhea (1832), acute yellow atrophy of the liver (1836), unilateral convulsions or Jacksonian epilepsy (1836), and "status lymphaticus". This great physician was also an able botanist and geologist, and personally a simple, unprejudiced truth-loving man.

Thomas Addison (1793-1860), Bright's colleague at Guy's, was more the brilliant pathologic lecturer and diagnostician than the successful

practitioner. He was the first to employ static electricity in the treatment of spasmodic and convulsive diseases, and in collaboration with John Morgan, wrote the first book in English on the action of poisons on the living body (1829). In 1839, he published a good account of appendicitis. In 1849, Addison read a paper before the South London Medical Society in which he described pernicious anemia and disease of the supra-renal capsules. These clinical notations were afterward expanded at full length in his great monograph On the Constitutional and Local Effects of Disease of the Suprarenal Capsules, which, in connection with the physiologic work of Claude Bernard, inaugurated the study of the diseases of the ductless glands. In 1851, Addison and Sir William Gull described the skin disease "vitiligoidea," now known as xanthoma. "Addison's keloid" is a circumscribed form of scleroderma.

The pathologist, Thomas Hodgkin (1798-1866) was a philanthropist and reformer. His reputation rests upon his original description of that simultaneous enlargement of the spleen and lymphatic glands or lymphadenoma. He also wrote an account of insufficiency of the aortic valve.

Probably the greatest of all illustrators of gross pathology was Sir Robert Carswell (1793-1857).

James Parkinson (1755-1824) is remembered today by his unique and classic description of paralysis agitans or "Parkinson's disease" (1817). He reported the first case of appendicitis in England. He was an able geologist and palaeontologist.

William Charles Wells (1757-1817) published perhaps the earliest clinical report on the cardiac complications of rheumatism.

Joseph Hodgson (1788-1869) gave the first description of aneurysmal dilatation of the aortic arch. James Hope (1801-41) did much for our knowledge of heart-murmurs, aneurysm and valvular disease, as summarized in his treatise on Diseases of the Heart and Great Vessels (1831).

The most important English treatise on the practice of medicine in the first half of the 19th century was the "Lectures on the Principles and Practice of Physic", published in 1843 by Sir Thomas Watson (1792-1882).

A prominent feature of English medicine in this period was the publication of admirable systems and encyclopaedias of medicine, such as those of Forbes (1833-35), Todd (1835-59), Tweedie (1840), South (1847), and Reynolds (1866-79).

A most important feature of British medicine in the 19th century was the work of the Anglo-Indian surgeons. It was not until well after Clive's victory at Plassey in 1757 that we see the Indian Medical Service playing much of a part in colonial and tropical medicine. The earliest treatise on tropical medicine was, in fact, published in 1768 by James Lind (1716-94), whose important work was followed in due course by an imposing array of books on the Indian climate and diseases, notably those of John Peter Wade (1791-93), William Hunter (1804), Sir James Annesley (1825), William

Twining (1832), Sir James Ranald Martin (1841), Allan Webb (1848), Charles Morehead (1856), and Goodeve's perennial little treatise on tropical pediatrics (1844). Aside from the development of tropical medicine, the organization of hospitals, of medical education, of public hygiene, and other administrative duties connected with the building up of the Indian Empire, the most important achievements of these army surgeons were their remarkable first-hand accounts of heat stroke, snake-bite, and the properties of far eastern drugs, many contributions to Indian botany, zoölogy, geology, and ethnography, the original accounts of cholera, beri-beri, scurvy, dysentery, leprosy, and filarial elephantiasis.

Two of the Anglo-Indian surgeons will always hold a high place in the history of serpent venoms, viz., Patrick Russell (1727-1805) whose Account of Indian Serpents was the earliest venture in the field, containing the original description of the celebrated Russell's viper (Daboia Russellii); and Sir Joseph Fayrer (1824-1907), whose Thanatophidia of India (1872) is one of the greatest classics of zoology. The greatest of the Anglo-Indian zoölogists was Thomas Caverhill Jerdon. Important original monographs on tropical diseases were John Peter Wade on fever and dysentery (1791-93), John MacPherson's Annals of Cholera (1839), Edward Hare on the treatment of remittent fever and dysentery (1847), Henry Vandyke Carter (1831-97) on mycetoma (1874), leprosy, and elephantiasis (1874) and spirillosis, and Leonard Rogers on Indian fevers (1897-1908),

and dysenteries (1913). Beri-beri had already been described in the 17th century by Bontius (1642) and Tulp (1652).

Charles Murchison (1830-79) entered the Bengal army in 1853. Returning to England, he became a prominent physician at the London Fever Hospital (1856-70), and St. Thomas' Hospital (1871-79), in connection with his wonderful special knowledge of fevers.

The name of Esdaile, of the Indian Medical Service, is prominently associated with the history of hypnotism, particularly of hypnotic anaesthesia in surgical operations. The pioneer of scientific hypnosis before Charcot was James Braid (1795-1861), a surgeon of Fifeshire, Scotland. His ideas were taken up by Azam, Broca, Charcot, Liébeault, and Bernheim. Hypnotism was first used in surgical operations by John Elliotson (1791-1868), who, in 1843, published a pamphlet describing <u>Numerous Cases of Surgical Operations without Pain in the Mesmeric State.</u> A far more impressive record was made by James Esdaile (1808-59), of Montrose, Scotland, who, in 1845, began to try hypnotism in operating on Hindu convicts. On returning to Scotland, he found that, except in disease, the self-contained Europeans differed from the impressionable, neurotic Hindus in not being specially susceptible to the hypnotic trance.

German medicine in the first half of the 19th century, laboured under the disadvantage of being split up into schools. The German people had to endure a long period of brutal military régime. In consequence, the

best minds of the time were driven into various idealistic modes of thought. During this period of idealism, the favourite philosophers were Schelling, Fichte, and Hegel. Clinical medicine was dominated by the fanciful reveries of the Nature-Philosophy School, of which Schelling himself was, indeed, the founder. Its principal spirit was the Bavarian naturalist, Lorenz Oken (1779-1851). Hard upon the Nature-Philosophy School followed the Natural History School. It was succeeded by the Rational or Physiologic School of Roser and Wunderlich, Henle and Pfeufer. The tendency of all these hole-and-corner schools was toward wholesale contempt for the scientific achievements of men like Bichat and Magendie, Laennec and Louis. The Revolution of 1848 dissipated the silly doctrines of the Nature-Philosophy School.

The first to break away from the jargon of the Nature-Philosophy School was Johann Lucas Schönlein (1793-1864), of Bamberg, the founder of the so-called Natural History School. In his progress from Würzburg to Zürich and Berlin, he passed through all three of the developmental phases of the Natural History School, the parasitic, the nosologic, and and scientific. In his clinic at the Charité, in Berlin, he was the first to lecture on medicine in German instead of Latin (1840), and was the founder of modern clinical teaching in Germany. He wrote little; his contributions of importance were his discription of peliosis rheumatica (Schönlein's disease) in 1837, his discovery of the parasitic cause of favus (achorion Schönlein) in 1839, and his proposal of the

terms "typhus abdominalis" and "typhus exanthematicus" to differentiate these diseases (1839).

The scientific movement in modern German medicine was started and kept in pace mainly through the medium of four important periodicals. Of the able editors, Müller, Henle, and Virchow were the leaders in Germany of comparative, histologic, and pathologic anatomy respectively, and Müller, in particular, was the greatest German physiologist of his time. Wunderlich was perhaps the most original clinician.

Carl Reinhold Wunderlich (1815-77) described renal apoplexy (1856), wrote a good treatise on practice (1858) and an excellent history of medicine (1859), but his masterpiece is undoubtedly his treatise on the relations of animal heat in disease (1868). In 1849, Thomson (Lord Kelvin) had established his "absolute scale of temperature", without which no thermometers could be reliable. Wunderlich made his book a permanent scientific classic. He found fever a disease and left it a symptom.

Josef Skoda (1805-81), of Pilsen, Bohemia, was the leading clinician of the New Vienna School and the first medical teacher in Vienna to lecture in German (1847). His principal contribution to medicine is his treatise on percussion and auscultation (1839). Skoda's resonance, the drum-like sound heard in pneumonia and pericardial effusion, is a permanent aid in modern diagnosis.

Carl Rokitansky (1804-78), Skoda's colleague and also a Bohemian,

did an enormous amount of pathologic work, and, it is said, had the disposal of between 1500 and 1800 cadavers annually. He was the first to detect bacteria in the lesions of malignant endocarditis, and to differentiate between Bright's disease and Speckniere (Virchow's amyloid degeneration of the kidney). Virchow knew more chemistry than Rokitansky, but he cordially admitted that, in picturing what was actually before him on the postmortem table, his Viennese rival was the ablest descriptive pathologist of his time. Rokitansky's finest productions are unquestionably his monograph on diseases of the arteries (1852), and his great memoir on defects in the septum of the heart (1875).

Dietl of Cracow is now remembered only by the painful symptoms in floating kidney.

Perhaps the most brilliant name of the New Vienna School, after Skoda's and Rokitansky's, was that of Ferdinand von Hebra (1816-80), the founder of the histologic school of dermatology. Hebra's classification of skin diseases (1845) was based upon their pathologic anatomy.

The greatest single achievement of the New Vienna School was the determination of the true cause and prophylaxis of puerperal fever. In the 18th century, Charles White, in Manchester, England, had enlarged upon the advantages of scrupulous cleanliness in these cases. On February 13, 1843, Oliver Wendell Holmes (1809-94) read to the Boston Society for Medical Improvement his paper On the Contagiousness of Puerperal Fever, in

which he affirmed that washing the hands in calcium chloride and changing the clothes after leaving a puerperal fever case was likely to be a preventive measure. Ignaz Philipp Semmelweis (1818-65), a Hungarian pupil of Skodå's and Rokitansky's, made a careful study of the autopsies in the fatal puerperal cases. In 1847, Kolletschka, Rokitansky's assistant, died of a dissection wound, and Semmelweis was present at the postmortem. He noticed that the pathological appearances were the same as in the unfortunate puerperae of the ward. He immediately instituted such precautions in the handling of labour cases that the mortality curve sank from 9,92 to 3.8 per cent. In the following year, he had a mortality as low as 1.27 per cent., through the simple expedient of washing the hands in a calcium chloride solution. Semmelweis is thus the true pioneer of antisepsis in obstetrics. He recognized puerperal fever as a blood-poisoning or septicemia (1847-49). He met with fierce opposition and left Vienna for Budapest, where he published his immortal treatise on "The Cause, Concept, and Prophylaxis of Puerperal Fever" (1861). But his sensitive nature was not equal to the strain of violent controversy, and brooding over his wrongs brought on insanity and death.

Medicine is also indebted to the New Vienna School for the introduction of laryngoscopy and rhinoscopy. The modern laryngoscope came to be invented by Manuel Garcia (1805-1906), a Spanish singing teacher

in London. Ludwig Türck (1810-68) wrote an important treatise on diseases of the larynx, with atlas (1866), and was an able neurologist. His studies on the sensible cutaneous areas of the separate spinal nerves (1856-68) are classic. He was also the first to note the correlation of retinal haemorrhage with tumours of the brain (1852).

Virchow was almost the only German spirit of his time who appreciated Bichat and Magendie, Bright and Addison.

One other prominent feature of German medicine in the early part of the 19th century was the rise of homeopathy. Its founder, Samuel Christian Friedrich Hahnemann (1755-1843), toward the end of the century, began to formulate the theories which characterize his system. These are, first, a revival of the old Paracelsian doctrine of signatures, namely, that diseases or symptoms of diseases are curable by those particular drugs which produce similar pathologic effedts upon the body (similia similibus curantur); secondly, that the dynamic effect of drugs is heightened by giving them in infinitesimally small doses; third, the notion that the most chronic diseases are only a manifestation of suppressed itch or "Psora".

Of the earlier American clinicians, those who did the most original work were Otto, the Jacksons, North, Ware, the elder Mitchell, Gerhard, and Drake. James Jackson (1777-1868) left one of the earliest accounts of alcoholic neuritis. James Jackson, Jr. (1810-34) first described

the prolonged expiratory sound as an important diagnostic sign of incipient phthisis (1833). Elisha North (1771-1843) published the first book on cerebrospinal meningitis ("spotted fever"). John Ware (1795-1864) wrote an important monograph on croup (1842); his exhaustive study of delirium tremens is, in connection with the earlier paper of Thomas Sutton (1813), the classic account of this neurosis.

John Kearsley Mitchell (1798-1858) became eminent as an internist, neurologist, and teacher. He wrote ably and suggestively on mesmerism, osmosis, liquefaction, and solidification of carbonic acid gas. His essay <u>On the Cryptogamous Origin of Malarious and Epidemic Fevers</u> (1849) files the first brief for the parasitic etiology of disease on <u>a priori</u> grounds.

Jacob Bigelow (1787-1879), of Massachusetts, was one of the greatest of American botanists.

William Wood Gerhard (1809-72) is memorable for the first definite separation of typhus and typhoid fevers (1837). His treatise on diseases of the chest (1842) was the most authoritative American work on the subject before the time of Flint. He left two contributions of enduring value, his monograph on tuberculous meningitis in children (1833-4), the first accurate clinical study of the disease, and his paper on differential diagnosis of typhus and typhoid fevers (1837).

The greatest physician of the West was Daniel Drake (1785-1852). He was one of Osler's "peripatetic physicians," constantly moving from place

to place in aid of the cause of medical education. He was also founder of the Western Journal of the Medical and Physical Sciences (1827-38). In 1841, Drake published one of the first accounts in literature on the local disorder known as "the trembles" or milk sickness. His crowning achievement was the great work on the Diseases of the Interior Valley of North America.

Of isolated discoveries in internal medicine in the first half of the 19th century, we may mention the original description of "kondee", or sleeping sickness, in the African travels of Thomas Winterbottom (1803).

The earliest 19th century exponent of anatomy and of scientific medicine in France was Marie-François-Xavier Bichat (1771-1802), the creator of descriptive anatomy. His Traité des membranes (1799-1800), his five-volume Anatomie descriptive (1801-3), and his work on general anatomy applied to physiology and medicine (1802) opened out an entirely new field for anatomists. His error was to assign a specific vital property, a different mode of vitalism, to each tissue.

In connection with Bichat's work may be mentioned the discovery of the third corpuscles or blood-platelets by Alexandre Donné (1801-78) in 1842.

Bichat's ideas were carried over into pathology by Jean Cruveilhier (1791-1873), of Limoges, a pupil of Dupuytren's, who left an early description of progressive muscular atrophy of the Aran-Duchenne type (Cru-

veilhier's palsy).

Sir Charles Bell (1774-1842), the leading British anatomist of the period, is now more celebrated as a physiologist and neurologist. He was a brother of John Bell, the well-known surgeon. Both the Bells had an uncommon artistic gift, and Charles, in particular, illustrated his System of Dissections and his Engravings of the Brain and Nervous System. He also lectured to artists, his "Anatomy of Expression" (1806) being a sequel of these studies. In 1811, Bell published A New Idea of the Anatomy of the Brain and Nervous System. This contains the first experimental reference to the functions of the spinal nerve-roots in literature. The conclusive proof that the anterior roots are motor, the posterior sensory, was made by Magendie upon a litter of eight puppies (1822). In 1826, Bell himself (in a letter of January 9th) had acquired a clear idea of the difference between sensory and motor nerves. In 1829, he demonstrated that the fifth cranial nerve is sensory-motor; discovered "Bell's nerve"; and also the motor nerve of the face (portio dura of the seventh nerve), lesion of which causes facial paralysis (Bell's palsy). He was an able surgeon, and attended the wounded after Corunna and Waterloo.

The main supporter of Bichat's ideas in Great Britain was the Scotch anatomist, Robert Knox (1791-1862), who was the first to teach general anatomy from the descriptive, histologic, and comparative angles. At this time, there were no public regulations to supply dissecting material

for teaching purposes. Body-snatching and even murder were rife. Lord Warburton's Anatomy Act of 1832 (2d and 3d William IV, cap.75) provided that all unclaimed bodies should, under proper conditions, go to the medical schools.

The leading comparative anatomists of the early 19th century were Lamarck, Cuvier, Owen, and Agassiz. Jean-Baptiste Lamarck (1744-1829) is now best remembered by his Philosophie Zoölogique (1809). In this he appears as a great pioneer of evolution. Georges Cuvier (1769-1832), whom Lamarch helped and who afterward turned against him, had, as Flourens said, "l'esprit vaste." His great works on comparative anatomy (1801-05), on the fossil bones of Paris (1812), on the structure of fishes (1828), and on the animal kingdom (1836-49) are on the most extended scale. He was the founder of vertebrate paleontology. Sir Richard Owen (1804-92), a pupil of Abernethy's, and the associate and son-in-law of John Hunter's secretary, William Clift, edited Hunter's posthumous works, and began his studies in morphology with his great Catalogue of the Physiological Series of Comparative Anatomy (1833-40). His Anatomy and Physiology of the Vertebrates (1866-68) was pronounced by Flower to rank next to Cuvier's Comparative Anatomy in scope. He described the Archaeopteryx, the oldest known bird, the Apteryx, Notornis, and Dinornis, the latter class including the dodo and the giant moa. He was also the first to describe the Trichina spiralis (1835). He was Hunterian professor at the Royal College of Surgeons (1836-56), and Superintendent of the Natural History

Department of the British Museum (1856-83). Louis Agassiz (1807-73), of Mottier, Switzerland, settled in Cambridge, Mass., in 1840, and his Contributions to the Natural History of the United States (1857-62) is of especial interest to Americans. His Fossil Fishes (1833-44), describing over 1000 species, is his masterpiece.

The pioneers of American anatomy in the first half of the century were Wistar, Horner, Godman, and Morton. Horner discovered the tensor tarsi muscle (Horner's muscle). In 1834, he showed that the rice-water discharges in Asiatic cholera consist of epithelium stripped from the small intestine.

In Germany, the development of anatomy and physiology went hand in hand, and the ablest of the earlier morphologists and histologists - Müller, Schleiden, Schwann, Henle, Remak - were also, in the best sense of the term, physiologists. The founder of scientific medicine in Germany was, indeed, Johannes Müller (1801-58). He was equally eminent in biology, comparative morphology, physiologic chemistry, psychology, and pathology, and through his best pupils - the histologists Schwann, Henle, Kölliker, and Virchow, the physiologists Du Bois Reymond, Helmholtz and Brücke - we may trace the main currents of modern German medicine. Müller's Handbuch der Physiologie des Menschen (1834-40) introduces two new elements into physiology - the comparative and the psychologic.

In embryology, Johannes Müller's name is associated with the discovery of the Müllerian duct (1825). In pathology, as in histology, he was one of the first to use the microscope, particularly in his monumental work on tumours (1838). Temperamentally, he was a mystic, and, by the same token, a vitalist in theory.

After Müller's time, the main trend of German anatomy was along histologic and functional lines, and this new departure turned upon three important factors - the foundation of modern embryology by von Baer (1827-28), the improvement of the achromatic microscope by Joseph Jackson Lister in 1830, and the development of the cell theory by Schleiden and Schwann (1838-9).

Carl Ernst von Baer (1792-1876), the father of the new embryology, was a native of Esthland, in the Baltic Sea provinces of Russia, and was successively professor at Dorpat, Königsberg, and St. Petersburg. The supreme merit of von Baer's work lies in the wonderful patience shown in working out, as Minot says, "almost as fully as was possible at this time, the genesis of all the principal organs from the germ-layers". Von Baer discovered the mammalian ovum in 1827, and, at the same time, the chorda dorsalis or notochord. From his exhaustive studies in comparative embryology, he was led to classify animals into four groups, viz., Vertebrata, Articulata, Millusca, and Radiata.

The development of the cell-theory, one of the fundamental principles

of modern science, was almost entirely the work of botanists. In the 17th century, Robert Hooke (1665), Malpighi (1675), and Nehemiah Grew (1682) had noticed the "small boxes or bladders of air" (cellular cavities) in cork and green plants. In 1831, the cell-nucleus was discovered by Robert Brown (1773-1858). The significance of the nucleus in vegetable histology was first emphasized by the Hamburg botanist Matthias Jacob Schleiden (1804-81). Schleiden saw and proved that plant tissues are made up of and developed from groups of cells, of which he recognized the nucleus (or "cytoblast") as the important feature. A friendly after-dinner conversation between Schleiden and Schwann, who in the meantime had discovered nucleated cells in the animal tissues, led Schwann to look for cells in all the tissues he knew of and to forumulate the most important generalization in the science of morphology, viz., the principle of structural similarity in animal and vegetable tissues.

Theodor Schwann (1810-82), born at Neuss near Düsseldorf, was a pupil of Müller's at Bonn and his prosector at Berlin. A most careful and accurate investigator, he discovered the sheath of the axis-cylinder of nerves, which goes by his name (1838), and the striped muscle in the upper part of the esophagus (1837).

Purkinje was the first to employ the term "protoplasm".

The importance of the cell theory is immediately sensed in the work of Jacob Henle (1809-85), the greatest German histologist of his time and one of the greatest anatomists of all time. He was the founder of modern knowledge of the epithelial tissues of the body. He also dis-

covered the external sphincter (striated muscle) of the bladder, the central chylous vessels, the internal root-sheath of the hair, and the Henle tubules in the kidney (1862). Altogether the histological discoveries of Henle take rank with the anatomical discoveries of Vesalius. Of his two books on anatomy, the earlier Allgemeine Anatomie (1841) was, in reality, the first treatise upon microscopic histology, and marks a great advance upon Bichat.

Robert Remak (1815-65), of Posen, was an assistant of Schönlein's at the Charité. In histology he is memorable for his discovery of the non-medullated nerve-fibre. In 1842, in Schönlein's clinic, he produced favus experimentally, in propria persona, separating the fungus from the genus Oïdium, and calling it Achorion Schönleini, after the master (1845). He was, with Addison and Duchenne of Boulogne, one of the pioneers of electrotherapy, substituting the galvanic for the induced current (1856).

Another important pioneer in the use of the microscope was Johannes Evangelista Purkinje (1787-1869), of Bohemia, who was also a physiologist of genius. As a microscopist, Purkinje was the first to use the microtome. He discovered the sudoriferous glands of the skin with their excretory ducts (1833), the pear-shaped ganglionic (Purkinje) cells in the cerebellum (1837), the lumen of the axis-cylinder of nerves, and the ganglionic bodies in the brain. Altogether a physiologist of extraordinary range and keenness of perception, he was further distinguished as a pharmacologist, his experiments on the action of camphor,

belladonna, stramonium, and turpentine having been made upon himself (1829).

After Henle's time, perhaps the most distinguished histologist of the early period was Albert von Kölliker (1817-1905). His "Microscopic Anatomy" (1850-54) and "Handbook of Human Histology" (1852) were the first formal text-books on the subject.

The first and greatest teacher of topographic and regional anatomy in the 19th century was Josef Hyrtl (1810-94). At the age of twenty-six he became professor of anatomy at Prague. He made no great discoveries but is to be regarded rather as the unapproachable teacher and technician. His Corrosions-Anatomie (1873) is a permanent memento of his unique skill in making anatomic preparations. These, the wonder and admiration of Europe, included his unrivalled collection of fish skeletons, all prepared by himself; his models of the human and vertebrate ear; his microscopic slides and the corroded preparations, consisting of injections of the blood-supplies of the different organs and regions, with the adjacent parts eaten away by acids, to show the finest ramifications. Hyrtl ranks with Emile Littré as one of the greatest of modern medical scholars.

After Müller's time, physiologic investigation proceeded along two broadly divergent lines. The physical school, which aimed at purely mechanical modes of experimentation and interpretation. The chemical

school attained its highest development in the epoch-making work of Claude Bernard and Pasteur.

The pioneer of experimental physiology in France was François Magendie (1783-1855), of Bordeaux, who, like Müller, employed both physical and chemical procedure in his investigations, and was incidentally the modern founder of experimental pharmacology. Unlike Bichat, Magendie had not the slightest use for vitalistic or other theories. As the ardent protagonist of experimentation on living animals he is, of course, the particular aversion of the anti-vivisectionists. His greatest contribution to the science was his experimental proof (on a litter of puppies) of the truth of Bell's law, that the anterior roots of the spinal nerves are motor, the posterior sensory in function (1822).

Magendie's investigations in pharmacology introduced bromine, iodine compounds, and such alkaloids as strychnine, morphine, veratrine, brucine, piperine, and emetine into medical practice (1821). His proof that secondary or subsequent injections of egg-albumen cause death in rabbits tolerant to an initial injection was the first experiment in anaphylaxis or supersentization of the tissues.

Marie-Jean-Pierre Flourens (1794-1867) is memorable as the discoverer of the <u>noeud vital</u>, or "vital node".

Jean-Léonard-Marie Poiseuille (1799-1869), of Paris, is permanently associated with the study of blood-pressure and the viscosity of the blood.

"Poiseuille's law", in recent times, has become fundamental in estimating the viscosity of the blood.

Ernst Heinrich Weber (1795-1878) was professor of anatomy and physiology at Leipzig (1821-66). He made an event in medical history by his discovery of the inhibiting power of the vagus nerve (1845). He and his brother Eduard Friedrich Weber (1806-71) did clever work together in measuring and comparing the velocity of the blood and lymph corpuscles in the capillaries, 1837.

A remarkable all-round physiologist and anatomist was Ernst Wilhelm von Brücke (1819-92), of Berlin.

The leading English exponent of physical experimentation in the early period was Marshall Hall (1790-1857), of Nottingham whose Royal Society memoir on The Reflex Function of the Medulla Oblongata and Medulla Spinalis (1833) established the difference between volitional action and unconscious reflexes.

It was Hall's work which gave "reflex action" a permanent place in physiology.

William Sharpey (1802-80), who was all his life a prominent teacher of physiology at University College, London (1836-74), is memorable for his papers on cilia and ciliary motion. Modern English physiology owes its origins to Huxley and to Sharpey, who was the teacher of the Cambridge and Oxford professors, Michael Foster and Burdon-Sanderson.

Sir William Bowman (1816-92), of Cheshire, England, eminent as physio-

logist and ophthalmic surgeon, discovered and described striated muscle (1840-41). To Bowman is due the scientific treatment of lacrimal disorders. In 1842, he stated his theory of the urinary secretion.

The chemical tendency in modern experimental physiology, which led up to the magnificent work of Claude Bernard and Pasteur, was initiated by Liebig and Wöhler in Germany, and by Dumas and Chevreul in France.

Justus von Liebig (1803-73) of Darmstadt, a pupil of Gay-Lussac, was the founder of agricultural chemistry. His laboratory, established at Giessen in 1826, was the first institution of the kind to be connected with university teaching. Here Liebig made his famous investigations of cyanides, cyanates, amides, aldehydes, benzoyls, benzoates, organic acids, and chemical fertilizers of soils. His most important contributions to medicine were his discoveries of hippuric acid (Poggendorff's Ann., 1829), chloral and chloroform (1831).

Liebig's investigations of fermentation and putrefaction were vitiated by his purely materialistic view of these phenomena, as based upon his theory of catalysis. He refused to believe that yeast is alive and declined to look through a microscope. Yet Liebig was otherwise an uncompromising vitalist.

Friedrich Wöhler (1800-82) was associated with Liebig. In 1828, he succeeded in effecting an artificial synthesis of urea by heating ammonium cyanate. This was the first time that an organic substance had

ever been built up artificially from the constituents of an inorganic substance, without any intervention of vital processes, and it soon became clear that there is no essential difference between the structural chemistry of life and that of inanimate nature. In 1824, Wöhler made, and in 1842 confirmed, a discovery which became the starting-point of the modern chemistry of metabolism, viz., that the benzoic acid taken in with food appears as hippuric acid in the urine. Other modes of animal synthesis, such as those of uric acid from ammonium carbonate or of glucose in the liver, were soon discovered.

Among the earlier chemical investigations of importance to medicine were Sertürner's isolation of morphine (1806); Kirchhoff's conversion of starch into sugar (1811); the isolation of strychnine (1818), brucine (1819), quinine, and veratrine (1820) by Caventou and Pelletier; Trommer's test for grape-sugar in the urine (Mitscherlich, 1841); and Pettenkofer's test for bile (1844). The chemistry of the urine derived a strong impetus from the brilliant work of Johann Florian Heller (1813-71), of the New Vienna School, a pupil of Liebig and Wöhler who devised the ring test for albumen (1844), and invented the ureometer for estimating specific gravity (1848).

The most important advance made by chemical investigation in the early period was in the physiology of digestion. The first work in this field, in order of time, was the graduating thesis of John R. Young.

In the 18th century, Réaumur isolated the gastric juice and demonstrated its solvent effect upon foods (1752). Spallanzani confirmed the fact of its solvent and antiseptic character (1782). Young took up his work at this point and, by experiments made upon bull-frogs, snakes, and even *in propria persona*, showed that the solvent principle of the gastric juice is an acid. In 1824, William Prout (1785-1850), an English chemist, was able to prove, by careful titration and distillation, that the acid of the gastric juice is free hydrochloric acid.

In 1833, William Beaumont (1785-1853), of Connecticut, a surgeon in the United States Army, published his famous "Experiments and Observations" on an accidental gastric fistula in the Canadian half-breed, Alexis St. Martin. Beaumont was the first to study digestion and the movements of the stamach *in situ* (1825), his was the most important work on the physiology of gastric digestion before the time of Pavloff.

Early 19th century surgery was mainly a continuation of the surgery of the 18th century, with this difference, that the centre of gravity had shifted from Paris to London, as a result of the mighty influence of Hunter's teaching. Of general operating within the cranium, joints, abdomen, and female pelvis, or in isolated organs like the eye and ear, there was no sign until well after the year 1867.

John Bell (1763-1820), of Edinburgh, belongs, in part, to an earlier period, but his great works upon surgical anatomy exerted a powerful in-

fluence. Like his brother Charles, John Bell was an artist of talent, one of the great medical men who have illustrated their own books. His most enduring contributions to surgery are his Discourses on the Nature and Cure of Wounds (1795), and his Principles of Surgery (1801-7). He went to Italy to die, leaving an enduring memento of his visit in his posthumous Observations on Italy (1825).

Sir Astley Paston Cooper (1768-1841), of Norfolk, a pupil of John Hunter's, was the most popular surgeon in London during the first quarter of the century. He was one of the pioneers in the surgery of the vascular system, in experimental surgery, and in the surgery of the ear. His books on Hernia (1804-07), Injuries of the Joints (1822), Diseases of the Testis (1830), and the Anatomy of the Thymus Gland (1832) are still remembered, as also Cooper's fascia, Cooper's hernia, and other eponyms.

Abraham Colles (1773-1843), of Dublin, professor of surgery in that city for thirty-two years (1804-36), was the leading Irish surgeon of his day. He is said to have been the first man in Europe to tie the innominate successfully. He wrote treatises on surgical anatomy (1811) and on surgery (1844-45), but his most important works are his original description of fracture of the carpal end of the radius or "Colles' fracture" (1814), and his Practical Observations on the Venereal Disease (1837), in which he states "Colles' law".

Robert Liston (1794-1847), of Scotland, was an Edinburgh graduate

who became professor of clinical surgery in University College, London, in 1834. He was a fine anatomist, and one of the most brilliant and skilful operators of his time. He was especially successful in plastic operations. In 1836, he successfully excised the upper jaw.

James Syme (1799-1870), of Edinburgh, was a cousin of Liston's and taught anatomy with the latter in 1822. When Liston went down to London in 1834, he succeeded to his very large Scotch practice. After Liston's death in 1847, Syme succeeded him in London. His most important contribution to surgery is his work on amputations and excisions. Syme was, with Pirogoff, perhaps the first European surgeon to adopt ether anaesthesia (1847), and, in 1868, he was the first to welcome the antiseptic method of his best and greatest pupil, his son-in-law, Lord Lister.

Sir William Fergusson (1808-77), of Prestonpans, Scotland, was the founder of conservative surgery. Between 1828 and 1864 he had operated 400 times for harelip, with only three failures, and 134 times for cleft-palate, with 129 successful cases.

Sir Benjamin Collins Brodie (1783-1862) was a pupil of Sir Everard Home. Being profoundly influenced by Bichat, he at first devoted himself to physiologic experimentation. In 1819 he published his classic treatise <u>On the Pathology and Surgery of Diseases of the Joints</u>.

James Wardrop (1782-1869), of Scotland, is now best remembered by

his Essays on the Morbid Anatomy of the Human Eye (1808) and by his method of treating aneurysm by ligating on the distal side of the tumour.

Amongst other prominent English surgeons during the pre-antiseptic period was William Hey (1736-1819), of Leeds, who first described infantile hernia (1764), internal derangement of the knee-joint (1782-1803), and devised a useful saw for operating in fractures of the skull (1803). Joseph Constantine Carpue (1764-1848) revived the Hindu method of rhinoplasty (1816).

The leading English military surgeon of the time was George James Guthrie (1785-1856), of London, who had served in America and in the Napoleonic wars. His most important work is his Treatise on Gunshot Wounds of the Extremities requiring Amputation (1815).

Dominique-Jean Larrey (1766-1842), the greatest French military surgeon of his time, also served in the Napoleonic wars. He was one of the first to amputate at the hip-joint (1803). His most interesting work is contained in his "Mémoires de Médicine Militaire" (1812-17), in which he gives the first account of "trench foot". He was the first to point out the contagious nature of Egyptian ophthalmia or granular conjunctivitis. Wound excision (1812) he got from Desault (1789).

The ablest and best trained French surgeon of his time was Guillaume Dupuytren (1777-1835). His lectures and his extensive practice

soon made him the leading surgeon of France. He endowed the well-known Musée Dupuytren at Paris, founded by Orfila. He was cold, hard, contemptuous, unscrupulous, and overbearing, and more respected than beloved.

Jacques-Mathieu Delpech (1777-1832), of Toulouse, was the pioneer of orthopaedic surgery in France. He was also one of the first after Hippocrates to point out that Pott's disease (spinal caries) is of tubercular nature (1816).

Alfred-Armand-Louis-Marie Velpeau (1795-1867) was not a scientific surgeon, but a strong, capable, hard-working teacher and operator.

Joseph-François Malgaigne (1806-65), the son of a French health officer, is described by Billings as "the greatest surgical historian and critic whom the world has yet seen," and he is, with Pétrequin, an authority on the surgery of the Hippocratic period.

Auguste Nélaton (1807-73), of Paris, who presided with Malgaigne at the Hôpital St. Louis, held the same unapproachable rank as an operator and teacher which Dupuytren had attained at an earlier period. He did most to establish ovariotomy in France.

Paul Broca (1824-80) was the founder of the modern surgery of the brain and also of the modern French school of anthropology. He was, in fact, the first to trephine for a cerebral abscess diagnosed by his theory of localization of function. In anthropology, Broca is, with Topin-

ard and Quatrefages, the greatest name of modern France.

Among the prominent German surgeons of the period were Vincenz von Kern (1760-1829), professor at Vienna (1805-24), who simplified wound-dressings by using bandages moistened with plain water (first proposed by Cesare Magati in 1616); and Conrad Johann Martin Langenbeck (1776-1851), professor of anatomy and surgery at Göttingen, who devised the operation of iridocleisis for artificial pupil (1817).

Carl Ferdinand von Graefe (1787-1840), of Warsaw, was one of the surgeons-general in the German struggle for independence (1813-15). He was the founder of modern plastic surgery and devised the operation for congenital cleft-palate in 1816.

Johann Friedrich Dieffenbach (1792-1847), of Königsberg, first treated strabismus by severing the tendons of the eye muscle (with success). He got wonderful results in tenotomy, skin-grafting, and orthopaedic surgery. He also made a brave attempt to treat vesicovaginal fistula.

Georg Friedrich Louis Stromeyer (1804-76), of Hanover, was the father of modern military surgery in Germany. He practically created the modern surgery of the locomotor system of applying subcutaneous tenotomy to all deformities of the body depending upon muscular defects. His methods were introduced into England by Little.

Bernhard von Langenbeck (1810-87) became the greatest clinical sur-

geon and teacher of his day in Germany.

Gustav Simon (1824-76) was the first in Europe to excise the kidney (1869). Albrecht Theodor von Middeldorpf (1824-68), of Breslau, performed the first operations for gastric fistula (1859).

The greatest of Russian surgeons, and one of the greatest military surgeons of all time, was Nikolai Ivanovitch Pirogoff (1810-81). In 1840 he was appointed professor of surgery at the Medico-Chirurgical Academy of St. Petersburg. He introduced many important reforms, among others the teaching of applied topographic anatomy. Through the aid of the Grand Duchess Helena Pavlovna, he introduced female nursing of the wounded in the Crimea. In 1847, he was already using ether anaesthesia in his surgical practice. He is noted for his great atlas of 220 plates (1851-54), in which frozen sections were first utilized on a grand scale in anatomic illustration; and for his treatise on military surgery (1864), in which he holds large hospitals responsible for the spread of epidemic diseases and recommends small, barrack-like pavilions.

American surgery in the pre-Listerian period was distinguished principally by a great deal of bold operating on the vascular and osseous systems, by the foundation of modern operative gynaecology at the hands of McDowell and Sims, and by the permanent introduction of surgical anaesthesia.

Philip Syng Physick (1768-1837), of Philadelphia, a pupil of John

Hunter's, and sometimes called the Father of American Surgery, was an Edinburgh graduate. He wrote nothing of consequence but is now remembered principally by his advocation of rest in hip-joint disease (1830), and the invention of the tonsillotome (1828). His modification of Desault's splint for fracture of the femur is still in use.

John Warren (1753-1815), of Roxbury, Massachusetts, rendered distinguished army service in the Revolution and was founder and the first professor of anatomy and surgery of the Harvard Medical School (1783).

Wright Post (1766-1822), of Long Island, N.Y., was the first in America to ligate the femoral artery successfully.

Valentine Mott (1785-1865), of Long Island, was a pupil of Astley Cooper, and, like him, a great pioneer in vascular surgery. The innominate artery was ligated for the first time in the history of surgery by Mott in 1818, the first successful operation being that of Smyth of New Orleans, in 1864.

The Civil War in the United States (1861-65) brought forth the remarkable Medical and Surgical History of the War of the Rebellion (1870-88), by Joseph Janvier Woodward, Charles Smart, George A. Otis, and David L. Huntington, a splendid collection of case histories and pathologic reports, embellished with fine plates. Another important surgical work which came out of this war was the study of "Gunshot Wounds and Other

Injuries of Nerves" (1864) by S. Weir Mitchell, George R. Morehouse, and William W. Keen.

The use of the soporific draught of Dioscorides and the soporific sponge of the Salernitans was unknown to Paré and died out in the 17th century, but it was sometimes customary for early 19th century surgeons to intoxicate the patient with alcohol or opium in cases requiring complete muscular relaxation, such as reduction of dislocations. In March, 1842, Dr. Crawford Williamson Long (1815-78), of Danielsville, having previously noted some accidental anaesthetic effects of ether, removed a small cystic tumour from the back of the neck of a patient under its influence. But Long published no reports of his results. In 1800, Sir Humphry Davy (1788-1829), of Penzance, England, experimented upon himself with nitrous oxide, and stated that "it may probably be used with advantage in surgical operations". In 1844, Horace Wells (1815-48), a dentist of Hartford, Connecticut, began to use nitrous oxide in dentistry, communicating his results to his friend and former partner, William Thomas Green Morton (1819-68); but a fatal case caused Wells to withdraw from practice. Morton learned that sulphuric ether is also an anaesthetic, whereupon he applied it at once in extracting a deeply rooted bicuspid tooth from one of his patients. Morton then visited Dr. John Collins Warren and persuaded him to give the new anaesthetic a trial in surgical procedure. The operation took place at the Massa-

chusetts General Hospital on October 16, 1846. On November 18, 1846, the discovery was announced to the world in a paper by Henry J. Bigelow. Robert Liston amputated a thigh under ether in December, 1846; Syme took it up in Edinburgh (1847), and Pirogoff wrote a little manual on etherization (1847), used later in Crimena experiences. The terms "anaesthesia" and "anaesthetic" were proposed by Oliver Wendell Holmes. On January 19, 1847, Sir James Young Simpson (1811-70), professor of obstetrics at Edinburgh, used ether in midwifery, but on November 4, 1847, he was led to substitute chloroform, the discovery of Liebig, Guthrie, and Soubeiran.

The founders of operative gynaecology were McDowell and Sims.

Ephraim McDowell (1771-1830) was a skilful and successful surgeon, especially in lithotomy. In December, 1809, he performed his first ovariotomy upon Mrs. Crawford, a woman of forty-seven, who thereupon lived to be seventy-eight. Ovariotomy had no existence in surgical practice before McDowell produced his results and put it upon a permanent basis. It was firmly established in English surgery through the labours of Charles Clay (1801-93), of Manchester, and Sir Spencer Wells (1818-97), of London.

James Marion Sims (1813-83), a graduate of Jefferson Medical College, Philadelphia (1835), soon became known as a capable and original surgeon. In making a digital examination he hit upon the peculiar late-

ral posture (Sims' position), which was to be the particular factor of his success in operating for vesicovaginal fistula. To the Sims position and the Sims speculum, which enabled the operator to see the condition"as no man had ever seen it before," he added a special suture of silver wire, to avoid sepsis, and a catheter for emptying the bladder while the fistula was healing. With these four coefficients, Sims perfected his operation for repairing this almost irremediable condition. He was one of the most original and gifted of American surgeons.

In the Woman's Hospital in New York, Sims was assisted by Thomas Addis Emmet (1828-1919), a native of Virginia, who, under his training, became a great master of the plastic surgery of the perineum, the vagina, the cervix uteri, and the bladder.

Josiah Clark Nott (1804-73) described the condition which Sir James Y. Simpson, in 1861, called "coccygodynia." Nott was also one of the first to suggest the "mosquito theory" in reference to the transmission of yellow fever (1848).

The advancement of scientific medicine in the second half of the 19th century was characterized by the introduction of a biological or evolutionary view of morphology and physiology, out of which came the sciences of cellular pathology, bacteriology, and parasitology, which had in them the germ of novel methods of treatment by means of sera and vaccines. The discoveries of Pasteur led immediately to Listerian or anti-

septic surgery.

The immense growth of general biology in our times was principally due to the evolutionary theories of Charles Robert Darwin (1809-82). Although an invalid Darwin laboured for twenty years before publishing his great work On the Origin of Species by Means of Natural Selection (1859). This theory was arrived at independently by Alfred Russel Wallace (1822-1913) in 1858. Both Darwin and Wallace owed much to the Essay on the Principle of Population of the English clergyman, Thomas Robert Malthus (1798). Darwin dispensed with the ancient Linnaean concept of the fixity of species, that animals and plants were originally created as we find them today, and the ghostly metaphysical abstractions which were invoked to "explain" why this should be. And though the idea of evolution was known to the Greeks and was more or less definitely outlined by Bacon, Buffon, Erasmus, Darwin, Goethe, Lamarck, Lyell, and Herbert Spencer, it became the salient fact of modern science through Darwin's work. The great monograph on The Expression of the Emotions in Man and Animals (1873) ranks with the contemporaneous work of Duchenne of Boulogne (1862).

Thomas Henry Huxley (1825-95) became a surgeon in the Royal Navy. His interest in biology was awakened by a sea voyage, a five years cruise on H.M.S. Rattlesnake (1846-50). Resigning from the navy, he became lecturer on natural history at the Royal School of Mines. The essays

on the Comparative Anatomy of Man and the Higher Apes (1859-62), and On Evidence as to Man's Place in Nature (1863), reveal the follower of Darwin, of whose ideas Huxley was indeed the ablest modern interpreter. No man ever fought more bravely and openly for truth and honesty, for the right of people to think and express their own thoughts.

Ernst Haeckel (1834-1919), of Jena, a great morphologist, carried Darwinism into Germany, where the opposition of Virchow created the necessity for such a champion. In 1868, appeared his "Natural History of Creation". He combined an iron-clad materialism, like that of the French Encyclopaedists, with the notion that aggregations of molecules have souls (Plastidul-Seelen), which was ridiculed by Virchow.

The problem of heredity was attacked in four different ways by Mendel, Hering, Galton, and Weismann.

Gregor Mendel (1822-84), abbot of the Augustinian monastery at Brünn, Austria, discovered the mathematical law governing the dominant and recessive characters in hybrids (1866-67), the application of which belongs to the 20th century.

Ewald Hering (1834-1918), a Saxon professor, advanced the psychophysical theory (1870) that facultative memory is the distinctive property of all living matter. The transmission and reproduction of parental characters are supposed to be the result of the organism's unconscious memory of the past.

Sir Francis Galton (1822-1911), a cousin of Darwin's, began to investigate heredity experimentally in 1871. In his book on Natural Inheritance (1889), he proceeds by statistical induction, to the Law of Filial Regression, which asserts that the offspring of parents unusual in height, talent, etc., regress to the average of the stock; also to the Law of Ancestral Inheritance, in virtue of which each parent contributes one-fourth $\left[(\frac{1}{2})^2\right]$ of the total inheritance, each of the four grandparents one-sixteenth $\left[(\frac{1}{2})^4\right]$, each of the eight great-grandparents $\frac{1}{128} = (\frac{1}{2})^8$. Galton's work on finger-prints (1892) is the first contribution of importance after Purkinje.

An important extension of evolutionary theory is the idea of the unbroken continuity or immortality of the germ-plasm, which was elaborated by August Weismann (1834-1914). He maintained that variation is produced by sexual selection, and held that the germ-plasm in the sex-cells is to be found in the chromosomes (idants) and predicted the "reduction division" (by one-half) in the maturation of the sex-cells and the "equation divisions" or equal division of the chromosomes. Another feature of Weismann's theory is his experimental proof that characters are not directly transmitted.

Anthropology was built up by the labours of such men as Darwin, Huxley, Lyell, Spencer, Prichard, and Tylor in England; in France, by Broca. Physical anthropology was developed through the craniological

investigations of Broca and Virchow, the treatises of Paul Topinard, Quatrefages' studies of fossil and savage men (1861), Virchow's statistics on the physical anthropology of the Germans (1876), and Lombroso's books on genius and insanity (1864). Medical anthropology, yet in its infancy, has for its basic data such finds as Dupuytren's radius curvus, Hutchinson's teeth, and the studies of Sir Marc Armand Ruffer (1859-1917) on palaeopathology (1909-14). The discovery of the prehistoric skull and skeletal remains at Neanderthal in 1856, which Virchow pronounced diseased, Broca normal, and Huxley human but ape-like, led Huxley to his famous assignment of man's place in nature as "more nearly allied to the higher apes than the latter are to the lower" (1860).

After the labours of such masters as Bichat, Bell, Henle, and Hyrtl, there was little to be added to the subject of descriptive human anatomy and most investigation in this field became merged into morphology and histology. There were isolated discoveries in plenty. Perhaps the most important of these was the description of the parathyroid glands by the Swedish anatomist, Ivar Sandström, in 1879.

The leading German anatomist of recent times was Wilhelm Waldeyer (1837-1921), who made important researches on the development of cancer (1867-72), retroperitoneal hernia (1868), and the ovary and ovum (1870). He first described the open ring of lymphoid tissue formed by the faucial, lingual, and pharyngeal tonsils (1884), which is now regarded as a prominent portal of infection.

English anatomy sustained a grave loss in the early death of Henry Gray (1825-61) whose anatomic treatise (1858), recently adapted to the B.N.A. terminology, has been the standard text-book of English-speaking students for over half a century.

John Goodsir (1814-67), of Anstruther, Fifeshire, succeeded to the chair of Monro tertius at Edinburgh (1845). His Anatomical and Pathological Observations (1845) contain the germinal idea of the cell-theory of Virchow.

Sir William Turner (1832-1916), of Lancaster, England, became Goodsir's assistant (1854) and successor (1867). He wrote the history of anatomy in the Encyclopaedia Britannica (1875).

Sir Arthur Keith, Hunterian professor at the Royal College of Surgeons, discovered (with Flack), the sino-auricular note in the heart (1907) and has written with ability on the anthropoid apes (1896), human embryology and morphology (1901), the antiquity of man (1914), and the endocrine aspects of race (1911-25).

Joseph Leidy (1823-91) was the leading American antomist of his time, and a biologist of the type of Hunter and Müller. He was America's greatest descriptive naturalist. He was the first to find Trichina spiralis in hogs (1846), made the first experiment in transplanting malignant tumours (1851), and, in 1886, found the hookworm in the cat and suggested that it might also be found in man as a cause of perni-

cious anaemia. He surmised that flies may be transmitters of wound infection, and was the first to separate out the parasitic amoebae (1879).

Oliver Wendell Holmes (1809-94) was Parkman professor of anatomy at the Harvard Medical School (1847-82), but he wrote many clever medical poems, and his "Medical Essays" (1883) was easily the most important American book dealing with medical history in its day.

After the time of Schleiden, Schwann, and Henle, the study of the finer or microscopic anatomy of the tissues became the word of ambition. In 1847, Joseph von Gerlach, Sr. (1820-96), of Mainz, began to inject capillaries with a transparent mixture of carmine, ammonia, and gelatine; by 1855, he was employing carmine as a nuclear stain for the tissues. Virchow did practically all his work with carmine. The microtome was definitely introduced by Wilhelm His in 1866.

The master worker in histology was Max Schultze (1825-74), of Freiburg, who was professor of anatomy at Halle (1854-9). He was an important contributor to marine zoölogy.

The next most important step in the cell doctrine was taken by Walther Flemming (1843-1905), of Schwerin, professor at Prague (1873-6), whose important monograph, Zellsubstanz, Hern- und Zelltheilung (1882), gives the classic account of cell division and karyokinesis.

Many important discoveries and innovations in histology were made such as Virchow's discovery of the neuroglia (1854), the islands of Langerhans (1869), and Ehrlich's investigations of the leukocytes (1880).

One of the most eminent of modern histologists was Magnus Gustav Retzius (1842-1919), a graduate of Lund (1871).

Toward the close of the 19th century, the storm centre of histologic controversy was the neuron theory, the doctrine of the physiologic autonomy of the nerve-cell and its branches. In 1850, Augustus Volney Waller (1816-70), of Faversham, England, showed that if the glosso-pharyngeal and hypoglossal nerves be severed, the outer segment, containing the axis-cylinders cut off from the cells, will undergo degeneration, while the central stump will remain relatively intact for a long period of time. This is the "law of Wallerian degeneration". In 1886, Wilhelm His showed how the nerve-cell develops from a columnar epiblastic cell into a neuroblast by thrusting out a pseudopodium. The staining methods of Ramon y Cajal (1903) were remarkable. Meanwhile the whole doctrine had been brought to a focus in the celebrated essay of Wilhelm Waldeyer (1891), which affirmed that the nervous system is made up of epiblastic cells or neurons each consisting of a cell-body with two sets of processes, an axon (axis-cylinder) having efferent (cellulifugal) functions and one or more dendrites with afferent (cellu-

lipetal) functions. The conclusion of the whole matter was reached in a series of beautiful and convincing experiments by Ross Granville Harrison (1870-   ), who eventually demonstrated the ameboid outgrowth of the nerve-fibres from the cell in an extravital culture (1910).

By the close of the 19th century, embryology had become a highly complex science. Highest among contemporary names, perhaps, stands that of Wilhelm His (1831-1904), of Basel, Switzerland, who did the best work of his time on the origin of tissues and the serial and morphological study of the embryonic and adult organism. In 1865, he published his great academic programme "On the Tissue-layers and Spaces of the Body."

In the meantime, His had been approaching his subject from a larger angle. A beautiful draftsman and a skilful photographer from boyhood up, his aim in teaching was to visualize everything to his pupils by means of microphotography, lantern-slides, models, and his own unrivaled drawings. He conceived the idea of a graphic reconstruction of the embryo in two and three dimensions (1868).

The problem of the dynamics of the maturation, fertilization, and segmentation of the ovum, which had remained insoluble since Harvey's time, was worked out in the following way: In 1826, Prévost and Dumas first described the segmentation of the frog's egg. The mammalian ovum was discovered by von Baer (1827), and was shown to be unicellular in every vertebrate by Gegenbaur (1861). The spermatozoa, discovered in 1677 by

Hamen, were shown, in a filtration experiment of Spallanzani's to be essential to fertilization (1786), and their cellular origin was demonstrated by Kölliker (1841). In 1865, Schweigger-Seidel and La Vallette St. George proved that the spermatozoön is a cell possessing a nucleus and cytoplasm. Its union with the ovum was first observed (in the rabbit) by Martin Barry in 1843. In 1875, Oscar Hertwig (1849-1922) demonstrated that the spermatozoön enters the ovum and that fertilization is accomplished by the union of the male and female pronuclei so formed. In 1883, Van Beneden discovered that the associated male and female pronuclei in the fertilized egg each contain half as many chromosomes as the normal body cells in the same species. In 1875, Flemming discovered the "centrosome."

The net result of the vast amount of embryological investigation, up to the year 1881, was summed up in the master-work of Francis Maitland Balfour (1851-82). At Cambridge, Balfour came under the influence of Michael Foster, and from that master he acquired his interest in embryology. In 1873, he went to study under Anton Dohrn at the Naples Zoölogical Station, and here he made an important research upon the embryology of Elasmobrach fishes. In 1880-81, appeared his great Treatise on Comparative Embryology.

The close resemblance between the early stages of the embryo in differen

animals had been noticed by Meckel and Oken. Van Baer is said to have admitted that he could not distinguish between three unlabelled embryos of a bird, a reptile and a mammal before him. Agassiz, in his Essay on Classification (1859), stated that the developmental phases of all living animals correspond to the morphological changes in their fossal successors throughout geological time. The De Vries theory, that species can originate by sudden jumps or mutations, has created a great spirit of antagonism to the old Darwinian idea of the slow, gradual evolution of species through accidental variations, although it is perfectly possible that both processes may coexist in the scheme of nature.

Among the important embryological researches of the century may be mentioned Wilheim Waldeyer's studies on the ovary and ovum, including his discovery of the germinal epithelium (1870).

Charles Sedgwick Minot (1852-1914), of West Roxbury, Massachusetts, professor of embryology and comparative anatomy at Harvard University, was the author of an important treatise on Human Embryology (1892).

Experimental embryology is a branch of experimental morphology or developmental mechanics, a phrase introduced by Wilhelm Roux (1850-1924), who may be regarded as the founder of the science.

The first step was taken by the physiologist Eduard Pfüger (1829-1910), who, in 1822-83, made a number of experiments on cross-fertilization

with different species of the frog. Hans Driesch (1867-) showed that continued pressure applied to an Echinus egg can produce a flat plate of 16 or 32 cells, which will proceed to an normal development in three dimensions, directly the pressure is removed.

The masters of physiology in the second half of the 19th century were Helmholtz, Claude Bernard, and Carl Ludwig. About the middle of the century the physical principles of the Conservation, Transformation, and Dissipation of Energy came into prominence.

Hermann von Helmholtz (1821-94), of Potsdam, was of mingled German, English, and French extraction, and was educated as a surgeon for the Prussian army. In 1849, he was appointed professor of physiology and pathology at Königsberg. His essay on the Conservation of Energy established the first law of thermodynamics, viz., that all modes of energy, e.g., heat, light, electricity, and all chemical phenomena, are capable of transformation from one to the other but otherwise indestructible and impossible of creation. That the muscles are the main source of animal heat was demonstrated by Helmholtz in isolated preparations (1848). In 1850-2, he measured the velocity of the nervous impulse with the pendulum-myograph of his invention. His invention of the ophthalmoscope (1851) made ophthalmology an exact science. His great Handbook of Physiological Optics (1856-67) is a permanent classic. Never has the subject of

acoustics been so exhaustively dealt with, except, perhaps, in Lord Rayleigh's treatise. In mathematical physics, Helmholtz made contributions of the first rank to the principles of dynamics, hydrodynamics, thermodynamics, and electrodynamics.

Yet, although he was an outstanding scholar, Helmholtz never forgot he was a physician. As a lecturer on "popular science," Helmholtz was approached only by Huxley, Tyndall, and Ernst Mach.

Emil du Bois Reymond (1818-96), of Berlin, the founder of modern electrophysiology, was of French extraction. Like Helmholtz, he was one of Johannes Müller's pupils, and succeeded the latter as professor of physiology at Berlin in 1858, holding the chair for the rest of his life. He introduced faradic stimulation by means of the interrupted (make and break) current from the special induction coil. In 1843, he noted that difference of potential between the cut end of an excised muscle or nerve and the uninjured end produces a current which can be demonstrated with a galvanometer. He showed that tetanized muscle yields an acid.

Du Bois Reymond wrote many fascinating essays and many fine biographical memoirs. Two have attracted especial attention - those on the Limits of Natural Science (1872) and the "Seven World-Riddles" (1880).

The work of Helmholtz and du Bois Reymond proved an efficient

stimulus to the study of the physiology of muscle and nerve, and to the introduction of new instrumental procedures. The method of obtaining myograms, introduced by Schwann (1837) and Helmholtz (1850) was vastly improved by Étienne-Jules Marey (1830-1904), of Paris. Investigation was also materially aided by such instruments as Gabriel Lippmann's capillary electrometer (1872), d'Arsonval's mirror galvanometer (1881),and Fick's tension writer (1882). Photography was effectively employed by Sir John Burdon Sanderson (1828-1905), and by Julius Bernstein (1839-1917) in measuring the time relations of the period of latent stimulation of muscle.

Hugo Kronecker (1839-1914), of Liegnitz, Silesia, distinguished himself particularly by his work on fatigue and recovery of striped muscle. The classic experiments of Bowditch and Kronecker on heart muscle, established the principle that the heart's motto is "all or none," <u>i.e.</u>, no matter what the stimulus, it will either contract to the fullest extent possible or not at all.

After du Bois Reymond, the most interesting investigations upon the physiology of nerve were the discovery of the inhibitory power of the vagus nerve by the Weber brothers (1845).

One of the most important experiments was the final demonstration of the indefatigability of nerve (1885) by Henry Pickering Bowditch (1840-1911), of Boston, Massachusetts, who did important work upon reenforce-

ment of the knee-jerk.

Bowditch's initial experiment in functional nerve blocking led in time to the conduction anaesthesia of Halsted and Cushing.

The starting-point of the neuron theory was the epoch-making experiment of Augustus Volney Waller (1816-70), of Elverton Farm, Kent. He showed that when a nerve is cut, the distal stump (the axis-cylinders, severed from the nerve-cells) will soon degenerate, while the proximal stump remains relatively intact (1850).

The theory that the functions of the brain can be localized in the cerebral cortex was introduced in somewhat fantastic form by Franz Joseph Gall (1757-1828), and by his pupil Johann Caspar Spurzheim (1776-1832), as phrenology.

The first real advance, after the experiments of Flourens and Legallois, was also the most important one, viz., the work of Gustav Fritsch (1838-97) and Eduard Hitzig (1838-1907), establishing the electric excitability of the brain (1870).

Motor aphasia from injuries or lesions in the region of the third left frontal (Broca's) convolution had, indeed, been established by Bouillaud (1825) and Broca (1861), and localized, epileptiform spasms from definite cerebral lesions had been described by Richard Bright (1836) and Hughlings Jackson (1875); but the experiments of Fritsch and Hitzig

upon the dog's brain were the first to show that local bodily movements and convulsions can be produced by stimulation of definite areas in the brain, always identical in different animals of the same species, and that per contra, removal of these areas will produce paralysis or loss of function of the corresponding parts of the body.

These observations were verified and greatly extended by the work of Sir David Ferrier (1843-1928), upon mammals, birds, frogs, fishes, and other creatures (1872-76).

Horsley and Schäfer (1884-8) and Beevor and Horsley (1887-94) have tended to confirm Ferrier's inference that the motor area of the cerebral cortex is around the central sulcus of Rolando. The main themata were most carefully confirmed on the clinical and pathologic side by Charcot and Pitres (1895).

The subject of the total functions of the cerebral hemispheres and the spinal cord will always be associated with the name of Friedrich Leopold Goltz (1834-1902), of Posen, one of Helmholtz's pupils, who became professor of physiology at Halle (1870-2). He did important work upon cardiac pressure, the mechanism of shock (Klopfversuch, 1862), and the functions of the semicircular canals (1870), but his most telling experiments were those upon the effect of excision of the brain and spinal cord in the frog (1869-72) and the dog (1874-96). Goltz's exposition of the

"spinal" animal as a brainless mechanism which, in Bernard Shaw's phrase, "blunders unto death," and of the animal deprived of its spinal cord as a conscious intelligence with lessened power of coördination and adaption, initiated much of the work of recent times upon the complex reflexes of the body.

The earliest investigation of the cerebellar functions was Rolando's Saggio of 1809. Flourens introduced the idea of nervous coördination. The effect of excision of the medulla oblongata and pons Varolii was investigated by Schrader (1887). The sympathetic system was investigated by Friedrich Wilhelm Bidder (1810-94) and Alfred Wilhelm Volkmann (1800-77), also Claude Bernard, W.H. Gaskell and J.N. Langley; and latterly by Henry Head.

The modern concept of reflex action was an outgrowth of the cell theory and (its most important corollary) the neuron theory. Türck's investigations of the cutaneous distribution of the separate pairs of spinal nerves (1858-68) were of capital importance. It became clear that most reflexes are compounded or coördinated, and that the nervous system functionates as a whole. This idea was specially developed by Charles Scott Sherrington. The whole trend of his teaching is to the effect that a reflex action is seldom an isolated phenomenon, but one in which several reflex arcs are concerned, so that the true function of the nervous system is to integrate the organism, in the sense of giving

it an individuality which is not possessed by a mere collection of cells or organs.

Experimental psychology began in Ernst Heinrich Weber's laboratory, and its modern phases are principally the work of Lotze, Fechner, and Wundt.

Rudolph Hermann Lotze (1817-81), of Bautzen, was the author of many important works on analytic psychology. Gustav Theodor Fechner (1801-87), professor of physics at Leipzig (1839-75), was perhaps the first after Weber to apply mathematical physics to the physiology of sensation. Wilhelm Wundt (1832-1920), of Neckarau, Baden, was professor of physiology at Heidelberg (1864). He wrote a text-book of physiology (1865), and three enduring memoirs on muscular motion (1858). The first of these is memorable for the famous "isotonic curves" produced by muscle under continuous and constant (amounting to continual) excitation.

Other noteworthy contributions to psychology are the measurement of the velocity of the psychic impulse by Donders (1868), the monographs of Duchenne and Darwin (1873) on the expression of the passions and emotions, and Freud on morbid sexual psychology.

Much of our knowledge of the digestive and vasomotor systems was developed by Claude Bernard (1813-78), the greatest physiologist of modern France. Magendie directed his genius into its proper channels. Magendie, after three or four demonstrations of Bernard's superb talents,

announced, with characteristic generosity, "You are a better man than I."

Like Magendie and Johannes Müller, Bernard made his bow to "vitalism," but he gave it the widest possible berth. He is the founder of experimental medicine, i.e., the artificial production of disease by means of chemical and physical manipulation. Through a number of ingenious experiments, he established the glycogenic function of the liver, and succeeded in isolating glycogen. This fact was more potent even than Wöhler's work in establishing the fact that the animal body can build up chemical substances as well as break them down. In 1849, Bernard made his celebrated discovery that a puncture (piqûre) of the fourth ventricle of the brain in dogs produces temporary diabetes. Equally important was his work on the pancreatic juice (1849-56). He showed that "gastric digestion is only a preparatory act," that the pancreatic juice emulsifies the fatty foods passing through the intestines, splitting them up into fatty acids and glycerin; and he demonstrated its power of converting starch into sugar. Bernard's third great achievement was his exposition of the vasomotor mechanism (1851-53). Among his lesser achievements are his experiments with curare (1850-56), in which by paralyzing the nerve, he demonstrated the independent excitability of muscle, and his investigations of carbon monoxide poison (1853-58), showing that it displaces the oxygen in the red blood-corpuscles. A special chair of general phy-

siology was created for him at the Sorbonne during Magendie's lifetime.

Of Bernard's pupils, Willy Kühne (1837-1900), of Hamburg, professor of physiology at Amsterdam (1868-71), and Heidelberg (1871-1900), is memorable for his investigation of the peripheral end-organs of the motor nerves (1862), of haemoglobin (1865), of the digestion of proteids by the pancreatic juice (1867), and particularly for the remarkable series of chemical studies of the intermediate products of peptic and intestinal digestion which he carried on with his pupil, Russell Henry Chittenden (1856-).

The classical account of the mechanism of the act of deglutition was that of Magendie (1817). The movements of the stomach were first studied <u>in situ</u> by William Beaumont (1825-33) and more accurately by Walter Bradford Cannon (1871-), who studied them with the Roentgen rays, after ingestion of bismuth (1898). Bidder and Schmidt (1852) proved that normally the gastric juice always contains hydrochloric acid in excess. The histologic changes in the gastric glands during secretion were studied by Heidenhain (1878), and intravitally by J. N. Langley (1880).

The movements of the intestines were studied by Carl Ludwig (1861), by W. B. Cannon, who observed them by means of the Roentgen rays, and by Bayliss and Starling, who described peristalsis as a reflex through the intrinsic ganglia (1899). The intrinsic nerve plexuses were described by Auerbach and Meissner (1862). Pflüger (1857) showed that stimulation of the splanchnic nerves inhibits the intestinal movements. Harvey

Cushing showed that, above and below the ileum, the intestines are relatively free from bacteria, and that the intestinal tract can be sterilized by fasting. Bilirubin was first isolated by Heintz (1851), and biliverdin by Berzelius (1840).

The scientific study of metabolism has been divided by von Noorden into three stages: First, the qualitative period, inaugurated by Liebig and Wöhler, in which the end-products of animal metabolism and the conditions of their formation were determined. Second, the quantitative period of von Voit and von Pettenkofer, in which food values were carefully studied in dietetic tables and the balance of nutrition determined, after which the thermodynamic relations of metabolic processes were calculated in terms of heat and energy units. Third, the recent era of the study of the intermediate products of metabolism.

Liebig was the first to classify the organic food-stuffs and the processes of nutrition (1842). The embryologist Theodor Ludwig Wilhelm Bischoff (1807-1882), of Hanover, was the first to demonstrate the presence of free CO_2 and oxygen in the blood (1837). His assistant, Carl von Voit (1831-1908), of Amberg, made many interesting studies on dietetics, particularly in his Handbook of the Physiology of Metabolism in Nutrition (1881), which introduced new methods of determining the intake and outgo in the balance of nutrition and the amount of proteid necessary in foods. In collaboration with the Bavarian hygienist, Max von Pettenkofer (1818-

1901), Voit first estimated the amounts of proteins, fat, or carbohydrates broken down in the body.

Max Rubner (1854-), of Munich, was one of the first to investigate metabolic changes in terms of heat and energy units by means of the calorimeter. The value of quantitative work by improved means has been especially shown in such researches as those of Atwater and Langworthy on the balance of nutrition (1898), and Chittenden on the minimum nutritive requirements of the body in relation to its capacity for work and nitrogenous equilibrium (1904). Friedrich von Müller first noted the striking increase of metabolism in exophthalmic goitre (1893).

The name of Rudolph Heidenhain (1834-97), professor of physiology at Breslau (1859-97), is intimately associated with the interpretation of all secretory phenomena as intracellular, rather than mechanical, processes.

The beginnings of the theory of the correlation of ductless glands and internal secretions were Claude Bernard's work on glycogen (1848-57), the pancreatic functions (1849-56), his fourth ventricle piqûre (1849), Addison's account of the suprarenal syndrome (1849-56), and the experiments of Brown-Séquard and Schiff.

Charles-Edouard Brown-Séquard (1817-94), was a native of Mauritius, but his life work was mainly associated with French medicine.

Moritz Schiff (1823-96), of Frankfort on the Main, was a zoölogist by training, and there are few aspects of physiology which he did not investigate. In 1867, in anticipation of Pavloff's pupils, he noted that the reflex flow of saliva in a dog with a parotid fistula varies with the methods and substances employed in stimulation. His epoch-making experiments were on the effects of excision of the thyroid in dogs, and their prevention by thyroid grafts and by the injection or ingestion of thyroid juices (1856-84).

"More than to any one else since the time of Harvey," says Sir Lauder Brunton, "do we owe our present knowledge of the circulation to Carl Ludwig ..." Carl Ludwig (1816-95), a native of Witzenhausen, was perhaps the greatest teacher of physiology who ever lived. He did but little independent writing. Most of his important discoveries were published under the names of his pupils. Ludwig's principal contributions to physiology are the introduction of the graphic method (1847), with new instruments, his discovery of the innervation of the salivary glands, and his many excursions into the physiology of the circulation. Nearly all these things were done before Ludwig went to Leipzig (1865).

Bowman and Heidenhain treated the glomerular epithelium as a secreting gland. Ludwig regarded it as a passive filter. In 1871, Schmiedeberg traced the accelerator fibres of the vagus nerve in the dog; and H.P. Bowditch, experimenting with an excised heart and a frog manometer,

showed that the heart muscle always gives a maximal contraction or none at all.

The innervation of the heart was investigated by Henle (1841); by Friedrich Bidder, who discovered the ganglionic cells at the junction of the auricles and ventricles (1852); by Albert von Bezold, who demonstrated the accelerator nerves of the heart and their origin in the spinal cord (1862); and by Walter Holbrook Gaskell. The pulse was specially studied by Étienne-Jules Marey (1830-1904), who invented the sphygmograph.

Olof Hammarsten (1841-) showed that coagulation is accomplished by splitting up of the fibrinogen with fibrin and other substances (1875).

Some of the best modern work on the circulation came from the Cambridge School of Physiologists, who were all pupils of Sir Michael Foster (1835-1907). He made an epoch in teaching which was only excelled by Ludwig's. His own experimental work was entirely on the heart.

Foster's pupils include the embryologist Balfour, Gaskell and Langley, Sherrington, Henry Head, and Charles Scot Roy (1854-97).

Henry Newell Martin (1848-96), of Newry, Ireland, professor of biology at the Johns Hopkins University (1876-93), carried Foster's methods of teaching into the United States.

The art of keeping animal tissues active extravitally was introduced by Carl Ludwig in his perfusion experiments (Bowditch, 1871), and was perfected by Sydney Ringer (1835-1910).

Walter Holbrook Gaskell (1847-1914) did the most important work on the heart after Ludwig, and laid the histologic foundations of the modern study of the autonomic nervous system. In 1881, he produced his great memoir on the musculature and innervation of the heart. He introduced the term "heart-block", and was the first to investigate the electrical condition of the heart with a galvanometer. In 1893, he showed that chloroform lowers blood-pressure by acting directly upon the heart and not on the vasomotor centre.

John Newport Langley (1852-1925), of Newbury, who succeeded Foster as professor of physiology at Cambridge (1903), made important investigations on the effects of pilocarpine (1874). The pupils of Gaskell and Langley include Gowland Hopkins, Elliot Smith, Sir Walter Fletcher, A.V. Hill, Barcroft, Anderson, Rivers, Dale, Lucas, Adrian and Elliott.

Sir Walter Morley Fletcher (1873-   ) is memorable for his work on intramuscular metabolism (1902-17).

Sir Frederick Gowland Hopkins (1861-   ), professor of biochemistry in the University of Cambridge (1914), devised a well known method of estimating uric acid in the urine (1892), analyzed tryptophan (with Cole, 1901) and isolated pure glutathione (1921), the nucleus of auto-oxidation in the cell. He argued that certain "accessory factors" in food are necessary to sustain life (1912), the starting-point of subsequent work on vitamine requirements.

John Scott Haldane (1860-   ), of Edinburgh, devised the standard apparatus and methods commonly used in gas analysis. As director of the Mining Research Laboratory of the University of Birmingham, his investigations of mine explosions, factory ventilation, the cell-storage and expulsion of dusts and the retention of siliceous dust (pneumonokoniosis), have been of great moment to industrial hygiene.

Joseph Barcroft (1872) author of an important memoir on the respiratory function of the blood (1914), investigated oxygen consumption in all the tissues (1908-14).

Archibald Vivian Hill (1886-   ) has done remarkable work on the thermodynamics of muscle (1909-27), particularly in the invention of instruments.

Sir Leonard Erskine Hill (1866-   ) has distinguished himself by his work on the cerebral circulation (1896), caisson disease (1912), the effects of humid heat and stuffiness (1910-23) and the physiologic effects of light (1923-7).

One of the greatest physiologists of France was the veterinarian Auguste Chauveau (1827-1917). He was abreast of Pasteur in his conception of the nature of pathogenic viruses (1868) and their attenuation (1883-4).

Charles Richet (1850-   ), of Paris, professor of physiology in the Paris Faculty, introduced the term "anaphylaxis" (1909).

Eugène Gley (1857-   ), of Épinal, professor of physiology in the Paris Faculty (1889), demonstrated the existence of iodine in the thyroid gland and the blood.

The most important work on respiration was done by Eduard F. W. Pflüger (1829-1910). He early made his mark as a master investigator by his monograph on electrotonus (1849). By his experiments in crossing species (1883) he became the founder of experimental embryology. The most effective work of Pflüger and his pupils is the proof that the essential seat of respiration is not in the blood, but in the tissues. Liebig had pointed out (1851) that the blood gases were probably in loose combination with some unknown substance, and this substance Hoppe-Seyler subsequently obtained in crystalline form as haemoglobin (1862-64). The discovery of Sir George Gabriel Stokes that oxygen can be removed from haemoglobin by reducing agents proved that the latter is the agent of combination (1864). The combining agency of the CO_2 is still obscure.

The action of the vagus on respiration was first investigated by Isidor Rosenthal (1864). In 1868, Ewald Hering and Breuer showed, by alternate closure of the trachea at the end of inspiration and expiration, that the mechanism of breathing is automatic and self-regulative.

In 1889, Henry Head, of London, working in Hering's laboratory at Prague, carried these experiments much further by such novel means as

freezing the nerve or etherizing it inside a rubber tube. The sense of his investigations is that the vagus acts like the governor of a steam engine in economizing the energies of respiration. Head, the editor of Brain, has also done most important work on the cutaneous distribution of pain and tenderness in visceral disease (1893-96).

Even before Pflüger, respiration of the tissues had been carefully investigated by Felix Hoppe-Seyler (1825-95), of Freiburg (Saxony), who is the greatest physiological chemist between Liebig and Emil Fischer. He is particularly remembered by his studies on the blood (1857-91), of which he made analyses for over thirty years. He was the first to observe the appearance of gas in the blood following a sharp and sudden fall of the atmospheric pressure.

Albrecht Kossel (1853-1927), of Rostock, professor of physiology at Marburg (1892-1901) and at Heidelberg (1901-1927), is to be remembered for his important work on the chemistry of the cell and its nucleus (1882-96), on nucleinic acid (1893), on albuminoids (1898), the discovery of adenin (1885), thymin (1894), thymic acid, histidin (1896), and agmatin.

Ernst Salkowski (1844-1923), of Königsberg, made the important discoveries of pathological excretion of phenol (1876), pentosuria (1892-5), peptonuria (1897), a quantitative test for oxaluria (1899), and made memorable investigations in digestion.

The physiological chemistry of the 19th century was rich in the discovery of new compounds, notably in the analysis and formulation of the decomposition products of proteids at the hands of Paul Schützenberger and others.

Both leucin and tyrosin were found in the pancreas after death by Virchow (1853). Acetone was discovered in diabetic urine by Wilhelm Petters (1857). Ehrlich introduced his diazo-reaction in 1882.

The rise of modern medicine is inseparably connected with the name of Rudolf Virchow (1821-1902), the founder of cellular pathology. In 1848, Virchow was sent by the Prussian government to investigate the epidemic of typhus or "famine" fever then raging among the weavers of Upper Silesia. His exhaustive account of what he saw and his recommendations included not only hygienic measures and a large charity for these unfortunates, but filed an actual brief for democracy and freedom. This bold pronouncement soon got Virchow into trouble with the governmental authorities, and, in 1849, he was deprived of his prosectorship. Seven years later he was asked to come back to Berlin upon honourable terms, and in 1856, was duly installed as professor of pathology at the University. He joined the Prussian Lower House in 1862, and from 1880 until 1893 he served in the Reichstag as a faithful and reliable representative of the rights of the people. As he grew older, honours came to him from all quarters. Shortly before his death he saw the completion of the

splendid municipal hospital in Berlin (January 15, 1902) which is now called by his name.

Virchow derived the inspiration for his life-work from Johannes Müller, and what he accomplished was in every way worthy of his great teacher. He was the first to observe and define leukocytosis. In 1846, he separated pyemia from septicemia, and between the years 1846 and 1856 created the doctrine of embolism. In 1856, he demonstrated the embolic nature of the arterial plugs in malignant endocarditis, and attributed the condition to parasites. As a parasitologist, he also did good work on trichinosis (1859-70), and discovered the sarcinic and aspergillic forms of mycosis in the lungs and bronchial tubes. In histology, he made two important discoveries - the neuroglia (1846) and the special lymphatic sheaths of the cerebral arteries (1851). He made hundreds of contributions to anthropology. He opposed the Darwinian theory; and the new views of Koch and Behring about toxins and antitoxins were hardly acceptable to one who had obliterated the humoral pathology.

Of Virchow's pupils, the most eminent was Julius Cohnheim (1839-84). Under Willy Kühne, Cohnheim made an important investigation on the sugar-forming ferments (1863). His monograph on inflammation and suppuration (1867-73) revolutionized pathology, showing, in direct opposition to the teaching of Virchow, that the essential feature of inflammation is the

passage of white bloodcells through the walls of the capillaries, and that pus and pus-cells are formed in this way from the blood. The summit of Cohnheim's experimental achievement was his successful inoculation of tuberculosis in the anterior chamber of the eye of the rabbit (1877).

Carl Weigert (1845-1904) is memorable for his investigations of the pathological anatomy of smallpox (1874-75), and Bright's disease (1879), and by the fact that he was the first to stain bacteria (1871). He introduced many improvements in the differential staining of the nervous system, notably with acid fuchsin (1882).

The first exhaustive treatise on pathology in English was that of Samuel David Gross (Boston, 1839).

The founders of bacteriology were Louis Pasteur and Robert Koch, the former being also the pioneer of modern preventive inoculation against disease, while to the latter we owe the development of the correct theory of specific infectious diseases.

Before the time of Pasteur, Leeuwenhoek had seen protozoa (1675) and bacteria (1687) under the microscope. Cultivation on solid media (potatoe) was first employed by Fresenius (1863), Hoffmann (1869), and Schröter (1875), who first identified bacteria by their cultural characteristics. Ferdinand Julius Cohn (1828-98) introduced the first morphological classification of bacteria (1870-75).

Louis Pasteur (1822-95) was born at Dôle (Jura), where his father, one of Napoleon's old soldiers, was a local tanner. He graduated at the École Normale at Paris in 1847. After this he was successively professor of physics at the Lyceum at Dijon (1848), professor of chemistry (1852-54) at the University of Strassburg, dean and professor of chemistry in the Faculty of Sciences at Lille (1854-57), director of scientific studies at the École normale at Paris (1857-63), professor of geology and chemistry at the École des beaux-arts (1863-67), professor of chemistry at the Sorbonne (1867-89), and director of the Institut Pasteur (1889-95).

As set forth in the inscriptions on the arches over his tomb, Pasteur is memorable for his work on molecular dyssymmetry (1848), fermentation (1857), spontaneous generation (1862), diseases of wine (1863), diseases of silkworms (1865), microörganisms in beer (1871), virulent diseases (anthrax, chicken cholera) (1877), and preventive vaccinations (1880), particularly of hydrophobia (1885).

The first of these, his classic investigations of the conversion of dextrotartaric acid into the inactive forms (racemic and mesotartaric acids) gained him the Rumford medal of the Royal Society. They also led Pasteur to the study of ferments and microörganisms. From this he proceeded to the discovery of lactic-acid bacteria. He next discovered the anaërobic character of the bacteria of butyric fermentation, and

demonstrated the rôle of microörganisms in changing atmospheric oxygen into CO_2 (1861). He discovered that the pellicle so necessary to the formation of vinegar from wine consists of minute, rod-like microörganisms (Mycoderma aceti). In 1867, the wine industry of France was worth 500,000,000 francs to the nation. This gain was due to Pasteur's discovery that the spoiling of wine by microörganisms can be prevented by partial heat sterilization (Pasteurization) at a temperature of 55° to 60° C. He discovered the cause and prevention of pébrine. In his studies on anthrax, he was preceded by Davaine, who discovered the bacillus; by Klebs, who indicated that anthrax virus is non-filterable, and by Koch, who first cultivated pure cultures of anthrax bacilli. He discovered, with Joubert and Chamberland, the bacillus of malignant edema (vibrion septique), the first find of an anaërobic microörganism of a pathogenic character. He discovered the Staphylococcus pyogenes in boils and the Streptococcus pyogenes in puerperal septicemia. His discovery of preventive inoculation was due to the accidental fact that virulent cultures of chicken cholera virus, during a vacation from the laboratory, became sterile or inactive, and, when injected, were found to act as preventive vaccines against a subsequent injection of a virulent character. In 1881, he succeeded in producing a vaccine against anthrax. Experiments with the viruses of anthrax, chicken cholera, and

swine measles (<u>rouget des porcs</u>) brought out the principle that the pathogenic properties of a virus can be attenuated or heightened. This principle was applied with success against anthrax in the sheep-folds near Chartres, and in preventive vaccinations against hydrophobia. Pasteur's first patient was Joseph Meister, 1885. Shortly afterward, the Pasteur Institute was opened, and special institutes for hydrophobia inoculations were founded all over the world. Here Pasteur laboured almost to the end of his life, with such brilliant pupils as Metchnikoff, Roux, Yersin, Calmette, Chantemesse, Chamberland, and Pottevin. With Ch. Chamberland, he devised the celebrated filter which is called by his name, while Emile Roux did epoch-making work on the diphtheria antitoxin, Metchnikoff on phagocytosis and the lactic-acid bacillus, Alexandre Yersin on the plague bacillus, and Albert Calmette on preventive inoculations against snake-bites.

Robert Koch (1843-1910), of Klausthal, Hanover, took his medical degree at Göttingen (1866), where he was profoundly influenced by the teachings of Jacob Henle, whose theory of contagion (1840) may have started Koch upon his life-work in science. He began with anthrax, and, in April 1876, reported to the eminent botanist Ferdinand Cohn at Breslau that he had worked out the complete life-history and sporulation of the anthrax bacillus. In November, 1877, he published his methods of

fixing and drying bacterial films on cover-slips, of staining them with Weigert's anilin dyes, of staining flagellae, and of photographing bacteria for identification and comparison. In 1878 appeared his great memoir on the etiology of traumatic infectious diseases. These three memoirs elevated Koch to the front rank in medical science, and, through Cohnheim's influence, he was appointed to a vacancy in the Imperial Health Department (Kaiserliches Gesundheitsamt). Here, in 1881, he produced his important paper upon the method of obtaining pure cultures of organisms by spreading liquid gelatin with meat infusion upon glass plates, forming a solid coagulum. The year 1882 was marked by the discovery of the tubercle bacillus by special culture and staining methods. This paper contains the first statement of "Koch's postulates." About the same time he and his assistants perfected Merke's idea of steam sterilization. In 1883, Koch, at the head of the German Cholera Commission, visited Egypt and India, discovered the cholera vibrio, its transmission by drinking-water, food, and clothing, and incidentally found the microörganisms of Egyptian ophthalmia or infectious conjunctivitis (Koch-Weeks bacillus, 1883). In 1885, he was appointed professor of hygiene and bacteriology at the University of Berlin, where his laboratories were crowded with bright pupils from all over the world, among whom were Gaffky, Löffler, Pfeiffer, Welch, and Kitasato.

At the tenth International Medical Congress at Berlin, in 1890, Koch

[illegible] In 1878 [illegible] on the etiology of traumatic infective diseases. [illegible] Health Department (Kaiserliches Gesundheitsamt). Here, in 1881, he published his important paper upon the methods of obtaining pure cultures of organisms by spreading liquid gelatin with meat infusion upon glass plates, forming a solid coagulum. The year 1882 was marked by the discovery of the tubercle bacillus by special staining and planting methods. This paper contains the first statement of "Koch's postulates." About the same time [illegible] sterilization. In 1883, too, as the head of the German Cholera Commission, Koch went to Egypt and India, discovered the cholera vibrio, its transmission by drinking-water, food, and clothing, [illegible] (Berlin, 1884). In 1885, he was appointed professor of hygiene and bacteriology at the University of Berlin, where his laboratories were crowded with eager pupils from all over the world, among whom were [illegible].

At the tenth International Medical Congress at Berlin, in 1890, Koch

announced his belief that he had found a remedy for tuberculosis - the introduction of tuberculin, his one mistake. In 1896, he investigated Rinderpest in South Africa at the request of the English government, devised a method of preventive inoculation, and made valuable studies of Texas fever, blackwater fever, tropical malaria, surra, and plague. In 1897, he produced his new tuberculin (T.R.). In 1902, he studied Rhodesian redwater fever (Küstenfieber), horse-sickness, trypanosomiasis, and recurrent fever in German East Africa, and, in the same year, established methods of controlling typhoid which have been adopted almost everywhere.

In 1906, he visited Africa again, at the head of the Sleeping Sickness Commission, introducing atoxyl for the treatment of the disease.

Edwin Klebs (1834-1913), of Königsberg, East Prussia, was professor of pathology at Bern (1866). With Pasteur, he was perhaps the most important precursor in the bacterial theory of infection; indeed, did most to win the pathologists over to this view. He saw the typhoid bacillus before Eberth (1881), the diphtheria bacillus before Löffler (1883), and investigated the pathology of traumatic infections before Koch (1871). In 1877, Klebs concluded that knowledge of the specific viruses (toxins) of pathogenic bacteria would be essential for further progress.

Friedrich Löffler (1852-1915), of Frankfort on the Oder, was for

many years a Prussian army surgeon. He discovered the bacteria of swine-erysipelas (1882-83), and glanders (1882); and established the causal relation of the diphtheria bacillus (1884), differentiating it from pseudo-diphtheritic organisms. In his investigations of the foot-and-mouth disease (1898), he was able to prove experimentally that the latter is caused by a filterable virus, establishing this concept and introducing a preventive inoculation against the disease (1899).

Georg Gaffky (1850-1918) discovered the bacillus of rabbit septicaemia, and first obtained a pure culture of the typhoid bacillus. Ferdinand Hueppe (1852-), a Prussian army surgeon, collaborated with Koch, and did important work on fermentation (1883), the bacteriology of milk (1884-1912), chlorophyll (1887-1905), water supply (1887-9), disinfectants (1886-91), cholera (1887-92), and racial and social hygiene (1895). Carl Flügge (1847-1923) wrote two well-known books on microörganisms (1886) and hygiene (1889).

The work of these men led to a wonderful output of epoch-making discoveries in bacteriology and parasitology, which went to the creation of the newer public hygiene and the virtual annihilation of most of the communicable diseases. Amongst these are the discovery of the bacteria of leprosy in 1871-4 by Armauer Hansen (1841-1912), of gonorrhea in 1879 by Albert Neisser (1855-1916), of typhoid fever by Carl Joseph Eberth (1880), of lobar pneumonia by Pasteur (1880-1), of glanders by Friedrich

Löffler (1882-86), of erysipelas by Friedrich Fehleisen (1883), of swine erysipelas by Löffler (1882-86), of diphtheria by Edwin Klebs (1883) and Friedrich Löffler (1883-84), of tetanus by Arthur Nicolaier (1884), of Bacillus coli infection by Theodor Escherich (1886), of Malta fever by Sir David Bruce (1887), of cerebrospinal meningitis (1887) by Anton Weichselbaum, of chancroid by Auguste Ducrey (1889), of influenza by Richard Pfeiffer (1892), of Bacillus aërogenes infection by William Henry Welch and George H.F. Nuttall (1892), of bubonic plague by Shibasaburo Kitasato and A. Yersin (1894), of dysentery by Kiyoshi Shiga (1897), and of whooping cough by Jules Bordet and Octave Gengou (1906). The microörganisms of the surgical and puerperal infections were discovered and investigated by Pasteur (1878-9), Koch (1878), Gaffky (1881), and Welch (1892). Toxins were first isolated and named (typhotoxine and tetanine) by Ludwig Brieger in 1888. The bactericidal effect of blood-serum was discovered by Hans Buchner (1889), bacteriolysis by Richard Pfeiffer (1894), bacterial hemolysis by Jules Bordet (1898). The subsequent discoveries of Maragliano (1892), Landsteiner (1902), and Eisenberg (1901), that the sera of diseased and even of normal donors, will hemolyze alien blood have revolutionized the whole subject of transfusion. Anaphylaxis was discovered by Edward Jenner (1798) and François Magendie (1839), and investigated by Simon Flexner (1894). Bacterial agglutination was discovered by Max Gruber and Fernand Widal

(1896). Opsonins were investigated by Denys and Leclef (1893) and by Wright and Douglas (1903). Parasitology was greatly advanced by such monumental treatises as those of K.A.Rudolphi on entozoa (1808-10), G.F.H. Küchenmeister on cestodes (1853), and parasites in man (1855), Carl Theodor von Seibold on teniae and hydatids (1854), Thomas Spencer Cobbold on entozoa (1864), Rudolf Leuckart (1822-98) on human parasites (1867), and Raphael Blanchard on medical zoölogy (1886-90). Of parasites producing disease, that of favus was discovered by Schönlein (1839), of psorospermosis by Johannes Müller (1841), of tinea favosa (alopecia) by David Grüby (1841-44), of anchylostomiasis by Angelo Dubini (1843), of recurrent fever by Otto Obermeier (1873), of malarial fever by Alphonse Laveran (1880), of Texas fever (piroplasmosis) by Theobald Smith (1889), the ray fungus (actinomycosis) in man by von Langenbeck (1848), in cattle by Otto Bollinger (1876), of blastomycosis by Thomas Casper Gilchrist (1896), and of sporotrichosis by Benjamin R. Schenck (1898).

The theory that mosquitos can transmit malarial fever was indicated even in the Sanskrit Susruta, and the same theory was advanced for yellow fever by Josiah Clark Nott, of South Carolina (1848), and Louis Daniel Beauperthuy (1854). The hypothesis was more definitely stated for yellow fever by Carlos Juan Finlay (1833-1915), of Cuba (1881), and for malarial fever by Albert F. A. King (1883). In the meantime Sir

Patrick Manson (1844-1923) had proved that the mosquito is a vector of Filaria sanguinis hominis (1877), and the plasmodium of malarial fever had been discovered by Alphonse Laveran (1845-   ), in 1880. These hemocytozoa were accurately described by Ettore Marchiafava and Angelo Celli (1885), and it was shown by Camillo Golgi (1844-1926), the histologist, that malarial paroxysms are coincident with sporulation of parasites (1886), and that the parasite of quartan fever differs from that of tertian (1889). In 1889, Marchiafava and Celli showed that the organisms of the pernicious and the tertian and quartan forms are different; B. Grassi and R. Feletti studied the parasites in birds (1891), D.L. Romanovsky devised a special stain for them, and Ronald Ross in India, demonstrated the infection of birds by means of the mosquito (1897-98), W.G. MacCallum and E.L.Opie demonstrated sexual conjugation in the flagellated forms (1897-98), and Grassi and A. Bignami showed that the parasites develop only in the Anopheles mosquito. That flies can transmit disease is one of the most ancient of folk-intuitions, implicit in the flea- and fly-amulets of the ancient Egyptians. Ambroïse Paré noticed that flies are disease-carriers at the battle of St.Quentin (1557), Joseph Leidy called attention to the fact in his hospital work during the Civil War (1861-65), and A. Raimbert demonstrated the transmission of anthrax by flies (1869). The agency of flies in the transmission of cholera was demonstrated by G. Tizzoni

and G. Cattani (1886), Angelo Celli showed that they may transmit tuberculosis (1888), and that the bacilli of anthrax, tuberculosis, and typhoid fever retain their virulence and reproductive power after passing through the intestines of the flies. In 1892, George M. Kober emphasized the importance of flies as disease transmitters and, in his report on typhoid fever in the District of Columbia (1895), definitely located them as such, in connection with a house-epidemic of typhoid from box-privies.

About 1890, Pasteur's theory of attenuated viruses was extended to the science of toxins and antitoxins by Emil von Behring (1854-1917). In his studies on chicken cholera, Pasteur had already noticed the pathogenic effects of a clear filtrate on the specific organism. In 1888, his pupils, Roux and Yersin, got the same results from diphtheria filtrates. Hans Buchner, in 1889, had established the bactericidal effect of blood-serum. While working in Koch's Institute with Kitasato, Behring demonstrated that the serum of animals immunized against attenuated diphtheria toxins can be used as a preventive or therapeutic inoculation against diphtheria in other animals. It soon became recognized as the specific treatment for diphtheria. Meanwhile the subject of immunity was developed on the solidist or cellular side by Elie Metchnikoff (1845-1916), the eminent Russian biologist, who, in his studies of <u>Daphnia</u> (1884), showed how ameboid cells in the connec-

tive tissues and the blood engulf solid particles and bacteria, destroying bacteria by absorbing them (phagocytosis). During 1892-1901, in fact, Metchnikoff developed the essential locus and functions of the reticulo-endothelial system. Metchnikoff also demonstrated that Pfeiffer's phenomenon (bacteriolysis) can take place in vitro (1895). With Roux, he showed that the higher apes can be inoculated with syphilis (1903-4).

Hans Much (1880-), of Zechlin, is memorable for his work on leprosy (nastin reaction 1909-10).

Sir Almroth Edward Wright (1861-) was the first to point out the rôle of calcium salts in the coagulation of the blood (1891). He made typhoid vaccination practicable (1896-7), having inoculated over 3000 soldiers in India (1898-1900), and the entire British forces in the South African War. Through this work, he originated general vaccinotherapy (1902-7), with the superadded feature of measuring the protective substances in the blood by means of the opsonic index (1903). He is the author of treatises on anti-typhoid inoculation and immunization.

Fernand Widal (1862-) made his mark by his discovery of bacterial agglutination (1895) and its application in the diagnosis of typhoid (1896).

Bacteriology and pathology have been specially advanced in America by William Henry Welch (1850-). He discovered the Staphylococcus epidermidis albus and its relation to wound infection (1892), also the Bacillus aërogenes capsulatus (1892), and, with Flexner, demonstrated the

pathological changes produced by experimental injection of the toxins of diphtheria (1891-92). In 1926, he was called to the new chair of medical history in the Johns Hopkins University.

Simon Flexner (1863-) director of the Rockefeller Institute for Medical Research (1903), has distinguished himself by his work on terminal infections, his experimental work on venoms (1901), cerebrospinal meningitis, and infantile poliomyelitis (1910-13).

Victor Clarence Vaughan (1851-) was the first after Panum (1856) and Selmi (1878) to investigate the poisonous alkaloids and proteins, in particular tyrotoxicon (1885), ptomaines and leucomaines, and the bacterial proteids or cellular toxins.

Frederick George Novy (1864-), of Chicago, made culture investigations of the trypanosomes, and (with Knapp) discovered the special spirochaete of the American variety of relapsing fever (1906).

Ludvig Hektoen (1863-), of Westby, Wisconsin, professor of pathology in Rush Medical College, Chicago (1895), is one of the most eminent pathologists and bacteriologists in America. He has done much valuable work in experimental medicine.

George H.F. Nuttall (1862-), first summarized the rôle of insects, arachnids, and myriapods as transmitters of bacterial and parasitic diseases (1899).

Theobald Smith (1859-) has been one of the pioneers in the

theory of infectious diseases. In 1886, working with D.E. Salmon, he demonstrated that immunity from hog cholera can be secured by injection of the filtered products of the specific organisms. This was the first experiment in immunization. Smith's demonstration of the parasite of Texas fever (Pyrosoma bigeminum) (1889), and his work (with F.L. Kilborne) in tracing its transmission by the cattle tick (Boöphilus bovis), was a great advance in the science of protozoan disease (1893). He also demonstrated anaphylaxis (Richet, 1909) from the bacterial products of diphtheria prior to 1903.

Hideyo Noguchi (1876-1928), of Japan, introduced the luetin (cutaneous) test for syphilis (1911), first obtained a pure culture of Treponema pallidum and cultivated the microörganisms of infantile paralysis and rabies (1913).

Edward Carl Rosenow (1875-), of Alma, Wisconsin, has been the main protagonist of the doctrine of variability of bacteria.

William Hallock Park (1863-), of New York, is remarkable for his work on the bacteriology and serology of diphtheria (1892-1906).

Hans Zinsser (1878-), of New York, is the author of sterling text-books on bacteriology (1911) and of experimental researches on the Treponema pallidum.

Among women, Ruth Tunnicliff, of Chicago, is remarkable for her discovery of a diplococcus in measles (1917).

Lord Lister (1827-1912) was born at Upton, Essex (April 5th). His father, Joseph Jackson Lister, a London wine merchant, who devoted his leisure hours to optical problems, was, in a sense, the founder of modern microscopy through his epoch-making improvements in the achromatic lenses of the instrument (1830). Two of Lister's teachers, William Sharpey and Thomas Graham, were Scots, and it was upon their advice that he went up to Edinburgh to follow surgery under Syme. In 1860, Lister became professor of surgery in the University of Glasgow. Meanwhile, he had shown that the contractile tissues of the iris consist of smooth muscle, the first correct account of the mechanism of dilating the pupil (1852); he had studied the early stages of inflammation (1857). Early in his hospital experience, Lister had been deeply impressed with the high mortality from such surgical pests as septicemia, pyemia, erysipelas, tetanus, and hospital gangrene. These were the days of "laudable pus", but his attention was accidentally drawn to Pasteur's work. Perceiving that Pasteur's heat sterilizations would avail nothing here, he turned to chemical antiseptics. After trying out zinc chlorid and the sulphites, he hit, by lucky chance, upon carbolic acid. In 1867, he published the results of two years' work in two papers, the second of which bears the significant title, On the Antiseptic Principle in the Practice of Surgery. He proceeded to develop his thesis. All his life, he laboured constantly to improve his dressings. He boldly applied the antiseptic principle, and did as much to extend the domain of surgery as any man of his time. In 1869, Lister succeeded Syme at

Edinburgh, and, in 1877, accepted the chair of surgery at Kings College, London. He was president of the Royal Society during 1895-1900, and was the first medical man to be raised to the peerage (1897). The military applications of antisepsis, which Lister suggested in 1870, were not taken up until late in the Franco-Prussian War, but his methods were soon grasped by von Volkmann, Thiersch, Mikulicz, and others. Upon hearing of Semmelweis, in 1883, Lister generously declared him to be his forerunner. In the obstetricians' hands, Listerism is now the main safeguard of the woman in childbed. To Listerism are due all modern developments of the surgery of the hollow cavities of the body.

Of the surgeons of Lister's time, who developed his ideas in new fields, perhaps the first place belongs to Theodor Billroth (1829-94), the pioneer of visceral surgery. He was early interested in wound infections. He is especially remembered as the surgeon of the alimentary tract.

Vincenz Czerny (1842-1916) introduced the enucleation of subperitoneal uterine fibroids by the vaginal route (1881), and extended Billroth's work on the excision of the larynx, the esophagus, the kidneys, and general visceral surgery.

Karl Thiersch (1822-95), of Munich, was a great pioneer of Listerism, and through his studies of epithelial cancer (1865), phosphoric necrosis of the jaws (1867), the healing of wounds (1867), and his improvement in

skin-grafting (1874) was a prominent contributor to surgical pathology.

Richard von Volkmann (1830-89), of Leipzig, also did much to introduce antisepsis after the Franco-Prussian War, was the first to excise the rectum for cancer (1878) and described the so-called ischemic contractures or paralyses (1881), and cancer in paraffin-workers.

Friedrich von Esmarch (1823-1908), of Tönning, Schleswig-Holstein, was a great military surgeon. He is most memorable for his introduction of the first-aid bandage on the battle-field (1869-70), and for standardizing surgical hemostasis by the "Esmarch bandage".

Ernst von Bergmann (1836-1907), of Riga, Russia, greatly advanced cranial surgery.

Ernst Julius Gurlt (1825-99), of Berlin, holds a high place in medical literature as the historian of surgery par excellence.

In orthopaedics, especial distinction was attained by the Heine family; Adolf Lorenz (1854-), of Weidenau, Silesia, introduced the bloodless method of reducing congenital dislocations of the hip-joint by forcible manipulation.

Of the original operations by German surgeons of the 19th century, the first nephropexy was performed by Eugen Hahn (1881), the first excision of the gallbladder by Carl Langenbuch (1882), the first colostomy by Karl Maydl (1888), thoracotomy for empyema by Ernst Küster (1889),

resection of the rectum by Paul Kraske (1891), excision of the Gasserian ganglion by Fedor Krause (1893), and excision of the stomach by Carl Schlatter (1897). The introduction of the cystoscope (1877-78) by Max Nitze (1848-1906) vastly improved the surgery of the bladder.

Just Lucas-Championnière (1843-1913), who before his graduation (1870) entered Lister's service at Glasgow, did most for the establishment of antiseptics in France, and, as a pupil of Broca, did much for trephining.

Félix Guyon (1831-1920), professor of genito-urinary surgery at the Paris Faculty (1890), was one of the great teachers of this specialty in his time. Other French surgeons of note were Charles Sédillot (1804-83), who performed the first gastrostomy, and Paul Berger (1845-1908), who wrote an exhaustive monograph on the interscapulo-thoracic amuptation (1887).

Sir James Paget (1814-99) was serjeant surgeon to the Queen, receiving his baronetcy in 1871. A warm friend of Virchow, Paget was, like Brodie, a great surgical pathologist. His best works are his Lectures on Tumours (1851), Surgical Pathology (1863), Clinical Lectures and Essays (1875), the catalogue of the Pathological Museum of the Royal College of Surgeons (1882), of which he was president (1875), and his original descriptions of eczema of the nipple, with subsequent mammary cancer (1874), and the trophic disorder, osteitis deformans (1877-82).

Sir Jonathan Hutchinson (1828-1913), surgeon to the London Hospital (1859-83), was another able surgical pathologist, and is especially memorable for his description of the notched, peg-shaped incisor teeth (Hutchinson's teeth) in congenital syphilis (1861), "Hutchinson's facies" in ophthalmoplegia, "Hutchinson's mask" in tabes, and the unequal pupils in meningeal haemorrhage.

Sir Victor Horsely (1857-1916) was a pioneer in experimental surgery, particularly in his operations on the ductless glands. His suggestion that muzzling would stamp out rabies proved effective.

Hugh Owen Thomas (1834-91), a gifted orthopaedist, of Liverpool, wrote much on fractures and deformities (1876-91), invented the extension splint which proved so valuable during the World War.

Sir William MacEwen (1848-1924) is notable for his methods of osteotomy for genu valgum (1881), radical cure of oblique inguinal hernia (1887), and treatment of aneurysm by acupuncture (1890).

Sir Frederick Treves (1853-1923), of Dorchester, England, is widely known for his works on surgical anatomy (1883), intestinal obstruction (1884), and appendicitis and peritonitis.

Henry Jacob Bigelow (1816-90) was the leading surgeon of New England during his life-time. He was the first to excise the hip-joint in America.

Samuel David Gross (1805-84) was the greatest American surgeon of his time. He wrote the first exhaustive treatise on pathological anatomy

in English (1839), which passed through three editions and was highly thought of, even by Virchow. He gave the first account of the distribution of urinary calculus (1851), and the first description of prostatorrhea (1860).

William Williams Keen (1837-) was the author of an important work on the surgical complications and sequels of typhoid fever (1898). He was the first to tap the ventricles (1889).

Prominent American surgeons of the Listerian period were John Thompson Hodgen (1826-82), who devised many instruments and apparatus, in particular, his wire suspension splints for fracture of the femur and forearm; Charles McBurney (1845-1913) of Roxbury, Massachusetts, who discovered "McBurney's point" as a sign for operative intervention in appendicitis; Frank Hartley (1856-1913), of Washington, who originated intracranial neurectomy of the second and third divisions of the fifth nerve for facial neuralgia (1892); George Michael Edebohls (1853-1908), of New York who introduced the operation of renal decapsulation in the treatment of chronic nephritis and puerperal eclampsia; George Ryerson Fowler (1848-1906), who first performed thoracoplasty; and Charles Horace and William James Mayo, authors of many accepted improvements in visceral surgery.

Prominent in orthopaedic and plastic surgery was Frank Hastings Hamilton (1813-86).

The gynaecology of the post-Listerian period was, in the main, a

brilliant development of the operative principles which had been established by McDowell, Sims, Emmett, and Battey in America, Koeberlé in France, Gustav Simon in Germany, and Sir Thomas Spencer Wells (1818-97) in England. Wells, one of the greatest of the ovariotomists, was a native of Saint Albans, Hertfordshire, a pupil of Stokes and Graves in Dublin.

A gynaecologist of wider scope and even greater success was Robert Lawson Tait (1845-99). He was a violent and even truculent opponent of Lister. He was a pioneer in all phases of operative gynaecology, and the first to work out the pathology and treatment of pelvic haematocele.

Very substantial work was done on the pathological side by Carl Arnold Ruge (1846-1926) and Johann Veit (1852-1917), who described erosions of the cervix uteri (1877).

Samuel Jean Pozzi (1846-1918), of Paris, a highly skilled general surgeon, did most to make gynaecology a going concern in France. Howard Atwood Kelly (1858-   ) is a recognized leader of his science in America. He was a pioneer in the use of cocaine anaesthesia (1884). The first to employ the carbolic acid solution in obstetrics was Étienne Tarnier of Paris (1881), the inventor of the well-known axis-traction forceps (1877) and the introducer of milk-diet in pregnancy.

Important features of the pre-antiseptic period were the artificial induction of premature labour by Carl Wenzel (1804), and the establishment

of the contagiousness of puerperal fever by Holmes (1843) and Semmelweis (1847-61).

Morphological study of the deformed pelvis and of spinal deformity in relation to difficult labour has been almost exclusively in the hands of the German obstetricians. The osteomalacic pelvis was first observed by William Hunter and described by the younger Stein. The rachitic or pseudo-osteomalacic type was described by Smellie, Sandfort, and the younger Stein, and named by Michaëlis (1851).

After Semmelweis, the most prominent obstetricians of modern times were Simpson, Credé, and Braxton Hicks.

Sir James Young Simpson (1811-70), of Bathgate, Scotland, became professor of obstetrics at Edinburgh in 1840. As the first to employ chloroform in obstetrics and labour (1847), he made a great name for himself in the history of his science. He introduced iron wire sutures (1858), the long obstetric forceps, acupressure (1850-64), and many new "wrinkles" in gynaecology and obstetrics.

Carl Siegmund Franz Credé (1819-92), of Berlin, introduced two things of capital importance in obstetric procedure - his methods of removing the placenta by external manual expression (1854-60), and of preventing infantile (gonorrheal) conjunctivitis by instillation of silver nitrate solution into the eyes of the newborn (1884).

John Braxton Hicks (1825-97), of London, made an epoch in the his-

tory of obstetric procedure by the introduction of podalic version by combined external and internal manipulation (1863).

Ophthalmology and the surgery of the eye were put upon a scientific basis mainly through the labours of three men, Helmholtz, Albrecht von Graefe, and Donders. In 1820, Captain Charles Barbier laid before the Académie des Sciences a monograph on teaching the blind to read and write. The Barbier six-point system was introduced in Paris by Louis Braille, a blind teacher of the blind. In 1836, Braille introduced his system of musical notation for the blind.

Albrecht von Graefe (1828-70), of Berlin, the creator of the modern surgery of the eye, and indeed the greatest of all eye surgeons, introduced the operation of iridectomy in the treatment of iritis, iridochoroiditis, and glaucoma (1855-62), made the operation for strabismus viable (1857), and improved the treatment of cataract by the modified linear extraction (1865-68), which reduced the loss of the eye from 10 to 2·3 per cent. He made a brilliant diagnosis of embolism of the retinal artery as the cause of a case of sudden blindness (1859), and proceeded to point out that most cases of blindness and impaired vision connected with cerebral disorders are traceable to optic neuritis rather than to paralysis of the optic nerve. Graefe's clinic became famous all over the world. His pupils included nearly all the greater ophthalmologists of the 19th century, notably Forster, Saemisch, Lieberich, Pagenstecher,

Alfred Graefe, Jacobson, and Horner of Zürich.

Frans Cornelius Donders (1818-89) after 1862 devoted himself exclusively to ophthalmology. To this field belong his studies of the muscae volitantes (1847), the use of prismatic glasses in strabismus (1848), astigmatism (1862-3), and his great work on The Anomalies of Refraction and Accommodation.

Donder's work has been the main source of knowledge on the improvement of disorders of vision by spectacles up to the time of Gullstrand. In 1863, he succeeded Schroeder van der Kolk as professor of physiology at Utrecht. His most important contribution to physilogy was the first measurement of the reaction time of a psychical process (1868).

Prominent among von Graefe's pupils were his nephew, Alfred Karl Graefe (1830-99), who made a clinical analysis of disordered movements of the eye (1858); Alexander (1828-79) and Hermann Pagenstecher (1844-1918), the former of whom made his mark in the history of cataract by the extraction of the lens in the closed capsule through a scleral incision (1866); and Edwin Theodor Saemisch (1833-1909), who first described serpiginous ulcer of the cornea and its treatment (1870).

On the didactic side, the most eminent living ophthalmologist is Ernst Fuchs (1851-), of Vienna. He is the author of important monographs on sarcoma of the uveal tract (1882), blindness (1885), etc., of improvements of Jaeger's test-types, and of the out-standing German

treatise on eye diseases (1889).

Of works relating to the normal eye, we may mention Henry Gray's memoir on the optic nerves (1849). Colour-blindness was investigated by the Swedish physiologist Alarik Frithiof Holmgren (1831-97). The relation of eye-strain (asthenopia) and astigmatism to headaches and other neurotic symptoms was first noted by S. Weir Mitchell (1874). The bacteriology of the eye was especially advanced by Robert Koch, who discovered the bacilli of two different forms of Egyptian conjunctivitis (1883); by John E. Weeks, who found the same organism as the cause of "pink-eye" (1886); and by Victor Morax and Theodor Axenfeld, who simultaneously described the diplobacillary form of chronic conjunctivitis (1896-7).

Laryngology and rhinology were specially advanced by the introduction of laryngoscopy by Benjamin Babington (1829), Robert Liston (1837), Manuel Garcia (1855), and rhinoscopy by Philipp Bozzini (1773-1809). Intubation of the larynx in croup was introduced by Eugène Bouchut (1818-91) in 1856-8, first done in Paris in connection with tracheotomy by Trousseau (1851-59), and perfected through the conscientious labours (1885-88) of the self-sacrificing Joseph P. O'Dwyer (1841-98), of Cleveland, Ohio. Rudolph Voltolini (1819-89) first employed the galvanocautery in laryngeal surgery (1867) and performed the first laryngeal operation through the mouth with external illumination (1889).

The foundations of otology were the catheterization of the Eustachian tubes through the mouth by Guyot (1724) and Cleland (1741), the mastoid operations of Petit (1774) and Jasser (1776), Cooper's perforation of the tympanic membrane for deafness (1800), and the monographs of Valsalva, Cotugno, Scarpa, and others. Max Schultze described the nerve-endings in the labyrinth (1858), Helmholtz the mechanics of the ossicles and membrana tympani (1869), and Goltz the physiological significance of the semicircular canals (1870). Adam Politzer (1835-1920), of Alberti, Hungary, was the first to obtain pictures of the membrana tympani by illumination (1865). The pioneers of aural surgery in the 19th century were Sir Astley Cooper (1801) and Sir William Wilde (1843-53), and after their time the most important English work on the subject was that of James Hinton (1827-75), of Guy's Hospital (1874). The modern surgery of the ear and mastoid has been mainly the work of the Germans. In 1873, Hermann Schwartze (1837-1910) and Adolph Eysell described the method of opening the mastoid by chiseling. Aural vertigo was first described by Prosper Ménière (1799-1862) in 1861, was again noted by Charcot as "vertigo ab aure laesa" (1874), while the relations between nystagmus and vestibular or cerebellar disease had been noted by Purkinje and Flourens.

Modern dentistry, since the days of Fauchard, Pfaff and Hunter, has been largely developed by Americans. In England dentistry was lifted

from the status of a trade to that of a science by Sir John Tomes (1815-95), a surgeon, who early made his mark by his studies on the histology of bone and teeth (1849-56), and invented a practicable dental forceps (1839-40).

Neither the English nor the French clinical medicine of this period had the rigorous scientific tendency which characterized the German. In England, pathology was little studied after the time of Bright, Hodgkin, and Addison. The brightest phase of French medicine in the second half of the 19th century was its neurology.

In experimental medicine, Jean-Antoine Villemin (1827-92), of Prey (Vosges), a medical graduate of Strassburg (1852), and professor at Val de Grâce, achieved an undying reputation by his proof that tuberculosis is a specific infection, due to an invisible, inoculable agent and transmissible by inoculation from man to the lower animals (1865-69). Before the advent of Pasteur, these ideas could gain no credence, although Villemin did what he could to spread the doctrine of contagious phthisis.

Of the French clinicians, Armand Trousseau (1801-67), of Tours, a pupil of Bretonneau, occupied about the same position in French medicine as Bright and Addison, Stokes and Graves over the Channel.

Georges Dieulafoy (1839-1911), of Toulouse, wrote the most readable French treatise on internal medicine in his day (1880-84), and is otherwise remembered by his employment of the trocar in the treatment of pleurisy, hydatids, etc.

Jean-Alfred Fournier (1832-1914), of Paris, professor in the Paris Faculty, whose name is associated with the great venereal clinic at the Hôpital St. Louis, was reputed as a teacher of great power. With Diday, of Lyons, Fournier did most to develop the subject of congenital syphilis. He introduced the concept "parasyphilis" and his statistics on the causal relation of lues to ataxia and paresis (1876-94) are, with those of Erb, the most important contributions to the subject.

Henri Huchard (1844-1910) is especially remembered for his studies in therapeutics and particularly by his work on the clinical forms of arteriosclerosis.

Charles-Jacques Bouchard (1837-1915) was the first to call attention to autointoxication (1887).

Georges Hayem (1841-   ) was the father and founder of haematology.

Among the contributions of French clinicians are J.-A. Villemin's proof of the inoculability of tuberculosis (1868), the descriptions of chronic interstitial hepatitis (1874) by Georges Hayem, of cirrhotic jaundice (1875) by Victor-Charles Hanot (1844-96), of primary endothelio-matous hypertrophy of the spleen (1882) by Ernest Gaucher (1855-1918), and of enteroptosis and gastroptosis by Frantz Glénard (1885).

German clinical medicine in the second half of the 19th century includes such names as Frerichs, Traube, Kussmaul, Gerhardt, Ziemssen, Leyden, Senator, Naunyn, and Friedrich Müller.

Friedrich Theodor von Frerichs (1819-85), at forty, had already done his best work, his great monograph on digestion, his discovery of leucin and tyrosin in the urine of acute yellow atrophy of the liver (1855), his pathological studies of cirrhosis of the liver, pernicious malarial fever, and melanemia, and his books on Bright's disease (1851) and diseases of the liver (1858). Frerich developed scientific clinical teaching in Germany.

Ludwig Traube (1818-76) early made his mark as the founder of experimental pathology in Germany.

Adolf Kussmaul (1822-1902) was the first to describe "periarteriitis nodosa" (1866), progressive bulbar paralysis (1873), and diabetic coma with acetonemia, and the peculiar type of breathing ("air hunger") associated with the condition (1874). He was also the first to wash out the stomach with the stomach-tube for gastric dilatation (1867-69), to treat gastric ulcer with large doses of bismuth, and to employ thoracentesis (1868).

Ernst von Leyden (1832-1910), of Danzig, founded, with Frerichs, the Zeitschrift für klinische Medizin. He did most to promote the movement for hospitalization of phthisical patients in Germany.

Hermann Nothnagel (1841-1905) wrote an authoritative treatise on therapeutics. He is especially memorable for his encyclopedic Handbook of Special Pathology and Therapeutics in 24 volumes (1894-1905). He

first described universal anaesthesia or absence of all sensation in the body (Seelenlähmung) in 1887. His favourite clinical theme was the diagnosis of cerebral diseases.

Carl Gerhardt (1833-1902) devoted himself mainly to internal medicine, pediatrics, and laryngology. He made important contributions on laryngeal croup (1859), paralysis of the vocal cords (1863-72), laryngeal tumours (1896), and syphilis of the larynx and trachea.

Along with Gerhardt, the principal German contributors to pediatrics were Eduard Heinrich Henoch (1820-1910), of Berlin, who wrote a Clinic of Abdominal Diseases (1852-58), and described Henoch's purpura (1874) and dyspeptic asthma; Alois Bednar; and Theodor Escherich (1857-), of Munich, whose treatise on the intestinal bacteria of infants (1886), contains the first account of Bacillus coli infections.

The subject of scientific infant feeding was inaugurated by Philipp Biedert (1847-).

Of recent German pediatrists, the greatest was Otto Heubner (1843-1926), author of treatises on disorders of infant nutrition and originator of the method of caloric feeding.

Of all Frerich's pupils, Naunyn and Ehrlich have best followed the master's bent in experimental pathology and pathological chemistry. Aside from his earlier investigations of hydatids and the chemistry of the transudates, Bernard Naunyn (1839-) devoted his whole life to the study of

the liver and pancreas. In the book on biliary calculus, he introduced the new concept of "cholangitis" as an inflammation of the lining membrane of the smallest bile-ducts causing obliteration of their lumina. He introduced the term "acidosis" (1906) to define the metabolic condition of acid formation in diabetic coma.

Naunyn's pupils were Stadelmann (1853-) who investigated the relation of β-oxybutyric acid to diabetic coma (1883); Oscar Minkowski (1858-), of Alexoten, Russia, who described congenital acholuric jaundice with splenomegaly and urobilinuria (1900); Max Schrader (1860-), who made valuable studies on the inhibitory centre of the heart (1886); and Adolf Magnus Levy (1865-), whose name is particularly associated with diabetic coma and its treatment (1899-1909).

Carl von Noorden (1858-), of Bonn, Nothnagel's successor at Vienna, made important studies of albuminuria in health (1885), disorders of metabolism (1892-95), and the treatment of the same (1909).

Friedrich von Müller (1858-), of Augsburg, first noted the increased metabolism in exophthalmic goitre (1893).

Hermann Sahli (1856-), of Bern, is widely known for his books on percussion in children (1882) and methods of clinical investigation (1894).

Carl Anton Ewald (1845-1915), of Berlin, is known everywhere for his great work in disorders of digestion (1879-88), his use of intubation in

exploring the contents of the stomach (1875), and his "test-breakfast".

The most prominent clinicians and pathologists at Guy's Hospital during the later period were Gull, Wilks, and Hilton Fagge. Sir William Withey Gull (1816-90) was one of the first to note the posterior spinal lesions in locomotor ataxia, and was one of the pioneers in the use of male fern in tenia (1855) and of static electricity in the treatment of nervous diseases (1852).

Sir Samuel Wilks (1824-1911), in his writings, really gave the diseases called after Bright, Addison, and Hodgkin their place in English medicine. He himself introduced the term "enteric fever", and was one of the first to study visceral syphilis (1857-63).

Charles Hilton Fagge (1838-83), was an able pathologist and clinician. His Principles and Practice of Medicine (1885-86), which was completed by Philip Henry Pye-Smith (1840-1914) and Wilks after his death, is one of the solid books of the time.

Golding Bird (1814-54) described oxaluria (1842). Frederick William Pavy (1829-1911) was the first to describe cyclic or postural albuminuria (1885) and the typhoidal arthritis known as "Pavy's joint". He had probably the largest practice in London in diabetic cases, in the treatment of which he was particularly successful.

Sir William Jenner (1815-98) separated typhus from typhoid fever (1847), although ten years later than Gerhard in America.

Charles West (1816-98), whose Lectures on Diseases of Children was the best English work of his time, was the main founder of the Hospital for Sick Children in Great Ormond Street.

Other prominent English practitioners of the time include Thomas Blizard Curling (1811-88), who first noted myxedema; Sir Alfred Baring Garrod (1819-1907), who introduced the "thread Test" in gout (1848-54); Sir Thomas Barlow (1845-), who first described infantile scurvy (Barlow's disease, 1876-82), and George Frederick Still (1868-) who described arthritis deformans in children (Still's disease, 1896).

Sir Thomas Clifford Allbutt (1836-1925), Regius Professor of Physic at the University of Cambridge, described the histology of syphilis of the cerebral arteries (1868), and gave an early description of the joint symptoms in locomotor ataxis (1869). His valuable contributions on mediaeval science (1901) and surgery (1905), Greek medicine in Rome (1909), and Byzantine medicine (1913) give him a unique place among medical historians.

Sir William Osler (1849-1919), of Bond Head, Canada, Regius Professor of Medicine at the University of Oxford (1904) was one of the earliest investigators of the blood-platelets (1873), and described the erythematous swellings (Osler's spots) in malignant endocarditis (1908). His Principles and Practice of Medicine (1892, 9th ed., 1920) is the best English textbook on the subject in our time. When he came to die, Osler was, in a

very real sense, the greatest physician of our time.

In Osler's clinic at the Johns Hopkins, much important work was done, such as the studies of malarial fever by W.S. Thayer and others (1886-1902), the investigation of amebic dysentery by William T. Councilman and Henri A. Lafleur (1890-91), the finding of the microörganisms in gonorrheal endocarditis and septicemia by W.S. Thayer and George Blumer (1896), the studies of eosinophilia in trichinosis by Thayer and Thomas R. Brown (1897-98), the demonstration of sexual conjugation in the malarial parasites by William G. MacCallum and Eugene L. Opie (1897-98), and the exhaustive study of pneumothorax by Charles P. Emerson (1903).

Lewellys Franklin Barker (1867-   ) added much to the literature of neurology and clinical pathology.

William Sydney Thayer (1864-   ) made extensive investigations of malarial fever (1895-97) and typhoid fever (1904).

Austin Flint, Sr. (1812-86), of Petersham, Massachusetts, was, in his lifetime, an authority on medical practice and auscultation.

Jacob M. DaCosta (1833-1900), of Philadelphia, described irritable heart in soldiers (1862-71).

Edward Gamaliel Janeway (1841-1911) was the first to found an extensive whole-time consultant practice in America. He first called the attention of the American profession to leukemia (1876), the contagiousness of tuberculosis (1882) and the fever of tertiary syphilis (1898).

Henry Leopold Elsner (1857-1916) summed up the experience of a lifetime in his massive treatise on prognosis (1916), almost the only important work on the subject after Prosper Alpinus (1601).

Nathan Smith Davis (1817-1904) was the father of the American Medical Association.

Frank Billings (1854-) with E.C. Rosenow, and others, developed the doctrine of focal infection from bacteria of the streptococcus pneumococcus group <u>via</u> the teeth, tonsils, and other portals (1909-16).

Richard Clarke Cabot (1868-) introduced the idea of teaching medicine by case-histories.

Emanuel Libman (1872-) is remarkable for his original investigations of endocarditis, notably the subacute bacterial.

John Conrad Hemmeter (1864-) was a pioneer in radiography of the stomach (1896). Max Einhorn (1862-), of Grodno, Russia, a Berlin graduate and professor in New York, invented many ingenious devices and instruments, such as gastro-diaphany (1887), and stomach-buckets (1890).

Abraham Jacobi (1830-1919), of Hartum,Westphalia, a graduate of Bonn (1851), settled in New York in 1853, where he became honoured and revered as one of the leading practitioners in the country and the Nestor of American pediatrics.

Infant nutrition was first studied in a scientific manner in America by Thomas Morgan Rotch (1849-1914).

Among the many important advances in diagnostic procedure were the graphic method of investigating the pulse introduced by Karl Vierordt (1855), A. Stich's suggestion of the use of reflexes in diagnosis (1856), the sphygmomanometers of Ritter von Basch (1881), C. Potain (air sphygmomanometer) (1889), Scipione Riva-Rocci (1896-1903) and Leonard Hill (1897), the introduction of esophagoscopy by Kussmaul (1868), cystoscopy, urethroscopy, and rectoscopy by Max Nitze (1877), gastroscopy by Mikulicz (1881), direct bronchoscopy and suspension laryngoscopy by Gustav Killian (1898-1912); above all the x-rays (1893) by Wilhelm Konrad von Roentgen (1845-1923); Kernig's sign in cerebrospinal meningitis (1884), Henry Koplik's sign in measles (1898), Pietro Grocco's triangle in pleurisy (1902), Ehrlich's diazo-reaction (1883), and Matthew Hay's test for bile (1886).

Modern neurology is mainly of French extraction and derives from Duchenne, of Boulogne, through Charcot and his pupils.

The first real advance in the diagnosis of ataxia was made by Moritz Heinrich Romberg (1795-1873). His Lehrbuch der Nervenkrankheiten (1840-46) was the first formal treatise on nervous diseases. It contains the well-known "pathognomonic sign" that ataxics cannot stand with their eyes shut (Romberg's sign).

Guillaume-Benjamin-Amand Duchenne (1806-75) studied under Laennec, Dupuytren, Magendie and Cruveilhier in Paris, and devoted the rest of

his life to neurology and electrophysiology. Being timid and inarticulate in relation to public speaking, he was aided by his friend, the fair-minded and generous Trousseau, who, out of fondness for Duchenne, often voiced his ideas with effect in medical societies.

Faraday discovered induced currents (1831), and Duchenne employed these in the treatment of paralysis and other nervous disorders. He was the founder of electrotherapy. His electrophysiological analysis of the mechanism of facial expression under emotion, illustrated by many striking photographs (1862), is approached only by Darwin's work on the observational side. Duchenne was the first to distinguish between the different forms of lead palsy and of facial paralysis from lesions of the brain or nerves, including the rheumatic and lacrimal forms. But his great field was the spinal cord. He worked on infantile paralysis and spinal progressive muscular atrophy. The most definite thing which Duchenne described was the bulbar or glossolabiolingual paralysis (1860), which is known by his name, as also the pseudohypertrophic form of muscular paralysis (1868). The last four years of his life were clouded by arteriosclerosis of the brain, and he died forgotton; but he is, with Charcot and Marie, one of the greatest neurologists of France.

Contemporary with Duchenne and far superior in the scope and general accuracy of his work was Jean-Martin Charcot (1825-93), physician to the

great hospital of the Salpêtrière. Here, from small beginnings, he created the greatest neurological clinic of modern times. He was not only a great neurologist, but early made his mark in his lessons on senile and chronic diseases (1867), diseases of the liver, the biliary passages, and the kidneys (1877). He differentiated the essential lesions of locomotor ataxia and described both the gastric crises and the joint affections (Charcot's disease). He separated multiple sclerosis from paralysis agitans, although the "intentional tremor" which he signalized as a differential sign had been noted by Bernhard Cohn in 1860. "No writer", says Osler, "has more graphically described the tropic troubles following spinal and cerebral disorders, particularly the acute bedsore." Charcot was not deceived by the feigning of some of his patients, and, in the end, regarded hypnotism as a doubtful therapeutic measure. The soundness of his view is borne out in the modern tendency to merge the procedure into psychotherapy in which he was the pioneer.

Pierre Marie (1853-), of Paris, Charcot's ablest pupil, graduated in 1883. In 1886, he described, with Charcot, the peroneal type of muscular atrophy, and has made at least four original delineations of new forms of nervous disease. These are his descriptions of acromegaly, pointing out the pituary lesion (1886), hypertrophic pulmonary osteo-arthropathy (1890), hereditary cerebellar ataxia (1893), and the Strümpell-Marie type of spinal arthritis deformans (1898).

Jules Dejerine (1849-1917) is remarkable for his separations of

peripheral (neuritic) tabes from medullary tabes (1882-92), and of the scapulo-humeral and fascio-scapulo-humeral types of muscular atrophy.

Of other French neurologists associated with the Salpêtrière tradition Georges Gilles de la Tourette (1857-1904) was remarkable for his description of impulsive tic (1885) and his great treatises on hypnotism (1887) and hysteria (1891-5). Fulgence Raymond (1844-1910) became Charcot's chosen successor at the Salpêtrière (1894-1910). Joseph Babinski (1857-) is notable for his elucidation of the toe reflexes.

The ablest German neurologist, after Romberg, is Wilhelm Heinrich Erb (1840-1921). In 1865, he introduced the method of electrodiagnosis by galvanic and induction currents, wrote important hand-books on diseases of the cerebrospinal nerves (1874), and did much to establish the modern theory of the muscular dystrophies.

Other German neurologists of the period were Nikolaus Friedreich (1825-82), who described hereditary ataxia (1863-76); Otto Westphal (1833-90), of Berlin, who described agoraphobia, and signalized the knee-jerk in diagnosis; Heinrich Quincke (1842-1922), who described angioneurotic edema (1882), and introduced lumbar puncture (1895); and Adolf Strümpell (1853-1925) who described spondylitis deformans (1897).

The leading English neurologists of the period were John Hughlings Jackson (1834-1911) who did much to establish the use of the ophthalmoscope in diagnosing brain diseases (1863), made valuable studies of aphasia

(1864), and described unilateral convulsions or Jackonsian epilepsy (1875); Sir William Richard Gowers (1845-1915) is well known for his treatises on diseases of the spinal cord (1880), in which he described Gowers' tract, epilepsy (1881), diseases of the brain (1885) and the nervous system (1886-8), and did much to systematize existing knowledge of these conditions, also he invented the haemoglobinometer (1878); Henry Charlton Bastian (1837-1915) one of the founders of English neurology; and Sir Victor Horsley (1857-1916), who did admirable work on the physiology of the nervous system, the functions of the ductless glands, and, with Gowers, was the first to remove a tumour of the spinal cord (1888).

In America, George Miller Beard introduced the concept of neurasthenia or nervous exhaustion (1869); Francis Xavier Dercum, of Philadelphia, described adiposis dolorosa; Thomas G. Morton described metatarsalgia (1876); Bernhard Sachs (1858-), described amaurotic family idiocy (1887-96), the ocular manifestations of which had been noted in 1880 (Tay-Sachs disease) by Waren Tay (1843-1927); William F. Milroy, of Omaha, Nebraska, described persistent hereditary edema of the legs, or "Milroy's disease" (1892).

Charles Loomis Dana (1852-) was, with James Jackson Putnam (1845-1918), of Boston (1891), among the first to differentiate the primary combined scleroses.

Silas Weir Mitchell (1829-1914), the leading American neurologist of his time, was a graduate of the Jefferson Medical College, Philadel-

phia (1850). In 1859, with Hammond, he investigated the arrow and ordeal poisons, corroval and vao. With Edward T. Reichert he isolated the diffusible globulins of the venoms; his studies have an important bearing upon the more recent work of Fraser (1896), Calmette (1896), Preston Kyes (1902-3), Flexner and Noguchi (1909). In 1869, he pointed out the coördinating functions of the cerebellum. He made studies of gunshot and other injuries of peripheral nerves (1864) which were afterwards expanded in his important work, on Injuries of Nerves and Their Consequences (1872). Mitchell was the first to describe causalgia (1864), erythromelalgia, or red neuralgia (1872-78), and postparalytic chorea (1874), and he was (with William Thomson) the first to emphasize the importance of eye-strain as a cause of headache (1874). In 1875, Mitchell introduced a treatment of nervous disease by prolonged rest in bed, with such adjuvants as optimum feeding, massage, and electricity, the so-called "rest cure", or Weir Mitchell treatment.

In the world of letters, as poet and novelist, Mitchell has a place near Goldsmith and Holmes.

Other innovations in neurology were the original descriptions of unilateral paralysis with crossed anaesthesia by Brown-Séquard (1851), acute ascending paralysis by Octave Landry (1859), congenital cerebral spastic paraplegia by William John Little (1861), symmetrical gangrene by Maurice Raynaud (1862), disease of the crura cerebri (Weber's syndrome) by Hermann Weber (1862), alcoholic paraplegia by Sir Samuel

Wilks, syringomyelia with trophic disturbances by Augustin-Marie Morvan (1883), impulsive tic or saltatory spasm by Georges Gilles de la Tourette (1884), subacute combined degeneration of the spinal cord (1884) by Otto Leichtenstern (1845-1900), and progressive lenticular degeneration by S. A. Kinnier Wilson (1912). Herpes zoster was first ascribed to a lesion of the spinal ganglia by Friedrich von Bärensprung (1861-63), and was further localized as an acute haemorrhagic inflammation of the posterior spinal and cranial ganglia by Henry Head and A. W. Campbell (1900). The visceral neuroses were investigated by Sir Clifford Allbutt (1884), and the pathology of the cerebral circulation by Leonard Hill (1896). H. C. Bastian (1869), described what Kussmaul (1877) subsequently termed word-blindness (dyslexia, Rudolf Berlin, 1887) and word-deafness. Agraphia was described by W. Ogle. The delicate casuistry of amnesia, aphasia, and allied disorders of speech is ably discussed by Henry Head (1926).

After the time of Pinel and Reil, the treatment of the insane without mechanical restraints (open-door method) was advanced by John Conolly (1856) and by the Tukes. Another advocate of the no-restraint system was Wilhelm Griesinger (1817-68), who, apart from his work in psychiatry, distinguished himself by his early description of hookworm infection as "tropical chlorosis" (1886), and did much, in Germany at least, to clear up the status of typhus, typhoid, relapsing and malarial fevers, in his

monographs on infectious diseases.

Theodor Meynert (1833-92) described amentia. Carl Wernicke (1848-1905) described sensory aphasia, including alexia and graphia.

Emil Kraepelin (1856-1927), professor of psychiatry at Dorpat (1886), Heidelberg (1890) and Munich (1903), was the pioneer of experimental psychiatry (1896). He introduced a new and simple classification of insanity. A man of sound, positive intelligence and remorseless logic, Kraepelin was the great systematist of psychiatry, in which he brought order out of chaos.

Richard von Krafft-Ebing (1840-1902), of Mannheim, wrote the best German work on forensic psychiatry.

Of English psychiatrists, Sir Thomas Smith Clouston (1840-1915) wrote a volume of clinical lectures on mental diseases; Charles Arthur Mercier (1852-1919) was author of a text-book (1902), but his most valuable contributions are those on criminal responsibility; John Milne Bramwell (1852-) has written much on hypnotism; Sir Frederick Walker Mott (1859-1926) was author of the Croonian lectures on the degeneration of the neuron. L. S. Forbes Winslow (1844-1913) wrote treatises dealing with the legal (1874) and picturesque aspects of lunacy (1898-1912); Hugh Crichton Miller (1877-) has written interestingly on hypnotism.

Psycho-analysis was introduced by Sigmund Freud and C. G. Jung (1893-1909). Alcoholic paraplegia, already noted by James Jackson

(1822) and Sir Samuel Wilks (1868), was described as a polyneurotic psychosis by Sergiei Korsakoff (1887).

The later 19th century marks the scientific or parasitic period of dermatology, in which many cutaneous diseases were directly traced to microscopic organisms, especially under the leadership of Sabouraud and Unna.

Hebra's work was completed and extended by his son, Hans von Hebra (1847-1902), of Vienna, who wrote a text-book on skin diseases, described rhinoscleroma and rhinophyma, and by his pupil, the Hungarian Moriz Kaposi (1837-1902), who described pigmented sarcoma of the skin, diabetic dermatitis, and xeroderma pigmentosum. Sir William James Erasmus Wilson (1809-84) made an early reputation by his Dissector's Manual (1838), Anatomist's Vademecum (1840), and anatomical plates, his Diseases of the Skin (1842), and dermatological Atlas. He was the first to describe trichorrhexis nodosa (trichodasis, 1849), erythema nodosum (1857), lichen planus (1869) and dermatitis exfoliativa (1870). He brought Cleopatra's Needle to London and is said to have established the custom of a daily bath. Tilbury Fox (1836-79) author of two treatises (1863, 1865-75), an atlas (1875-77) and a famous book on endemic skin diseases of India (1876), identified the kerion of Celsus as ringworm, segregated impetigo contagiosa (1862), with an ammoniated mercury treatment, and described lymphangioma, dermatitis herpetiformis, and urticaria pigmentosa. David Grüby

(1810-98) described a contagious tinea sycosis. His work received little attention until the bacteriologic and parasitologic period, when it was taken up by Raymond Sabouraud (1864-) who made extensive studies of the different varieties of trichophyton, the etiology of eczema, diseases of the scalp (1902-), of pityriasis, and the "pellicular alopecias". Sabouraud did the best work on the mycotic diseases of the skin. Meanwhile extremely valuable work was done on the pathological, bacteriological, and therapeutic side by Paul Gerson Unna (1850-). He published valuable works on the anatomy (1882) and histopathology of the skin (1894) and the treatment of skin diseases (1898).

Among the original descriptions of skin diseases in the modern period are those of porrigo (1864), dysidrosis (1873), and hydroa (1880) by Tilbury Fox (1836-79), dermatitis exfoliativa by Erasmus Wilson, giant urticaria (angioneurotic edema), by John Laws Milton, epidermolysis bullosa by Alfred Goldscheider, varicella gangrenosa by Sir Jonathan Hutchinson, xeroderma pigmentosum, lymphodermia perniciosa, and lichen ruber moniliformis by Moriz Kaposi, follicular psorospermosis by Jean Darier; Thomas Caspar Gilchrist, blastomycetic dermatitis (1896); and Benjamin R. Schenck, sporotrichosis (1898).

The work of Magendie in experimental pharmacology was ably continued by Alexander Crum Brown and Thomas Richard Fraser. Buchheim, Schmiedeberg, and Binz in Germany, Brunton and Cushny in England, have done brilliant experimental work on animals. The whole tendency of recent pharma-

cology is in the direction of simplification and specificity. The only final test of the reliability of a drug is at the bedside.

The leading pharmacologists of the German school are Rudolf Buchheim (1820-79), who investigated the action of potassium salts, of purgatives, cod-liver oil, ergot, the mydriatic alkaloids of the Solanaceae, etc., and his pupil, Oswald Schmiedeberg (1838-1921), who discovered sinistrin (1897) and histozyme (1881), and did a great amount of critical and experimental work on muscarin, ferratin (1893), digitalis and other drugs, the tendency of which is crystallized in his well-known elements of pharmacology (1883).

Sir Thomas Lauder Brunton (1844-1916), full physician (1897-1904) to St. Bartholomew's, studied with Brücke, Kühne and Ludwig, and became a master in the application of the physiological findings of pharmacology to internal medicine. His special field was the action of drugs on the heart. In 1867, he ascertained that rise of arterial pressure is a feature of angina pectoria and recommended the exhibition of amyl nitrite on physiological grounds. He introduced the vasodilator remedies.

Sir Thomas Richard Fraser (1841-1920), of Calcutta, India, was one of the pioneers of experimental pharmacology through his original work on physostigmine (1863-7), strophanthus hispidus (1873-95), and his investigations of arrow-poisons and serpent venoms.

Arthur Robertson Cushny (1866-1926) was a pupil of Schmiedeberg (1891-3). His text-book of pharmacology and therapeutics (1899) is imbued with the spirit of his master. He did admirable work on the effects of digitalis on heart-muscle (1897-1925), and, in 1899, recognized the similarity between clinical delirium cordis and experimental auricular fibrillation.

Horatio C. Wood (1841-1920), of Philadelphia, was professor of botany (1866-76) and therapeutics (1876-1907), also professor of nervous diseases (1875-1901) in the University of Pennsylvania. He made an important investigation of the pathology of sunstroke (1872), and wrote a pioneer treatise on therapeutics (1874).

John Jacob Abel (1857-1938), of Cleveland, professor of pharmacology at the Johns Hopkins University (1893), was editor of the Journal of Pharmacology and Therapeutics. He first isolated epinephrin (1898) and bufagin (1911) and investigated the constituent of the suprarenal capsule which raises blood-pressure (1897-1905). His pharmacological studies of the phthaleins and their derivatives (1909) led to the universal clinical use of phenolsulphonephthalein as a functional test in renal disease by L. G. Rowntree and J. T. Geraghty. By vividiffusion (1912-14) Abel first obtained amino-acids directly from the blood.

Edward Robinson Squibb (1819-1900) was a pioneer in the insurance of purity in manufactured drugs, in which his name became a symbol of

honour; Charles Rice (1841-1901), of Austrian birth, was the most learned and versatile of American pharmacists.

Among the many new drugs introduced in recent times are lecithin (Gobley, 1846; Danilevsky, 1896), chloral (1869) by Oscar Liebreich (1838-1908), pilocarpin (Hardy and Gerard, 1873), vaseline (R. A. Chesebrough, 1875), antipyrin (Knorr), cocaine (as anaesthetic) by W. K. Anrep, formalin (I. Loew, 1885), ichthyol and resorcin by P. G. Unna, salol by M. von Nencki, acetanilide (antifebrine) by Arnold Cahn and P. P. Hepp (1886), phenacetine (Kast and Hinsberg), ephidrine (Nagai, 1887), sulphonal (Baumann, 1884), pyramidon (Filehne and Spiro, 1893), urotropin (Nicolaier, 1894), heroin by Dreser (1898), adrenaline (1901) by Jokichi Takamine (1854-1922), veronal (1904) and proponal (1905) by Emil Fischer and Joseph von Mering, salvarsan ("606") by Ehrlich (1909), sanocrysin by Møllgard (1913), and synthalin by E. Frank (1926).

Emetin, introduced by J. L. Bardsley, of Manchester, in 1829, as a remedy for dysentery, was found to be amecibidal by Edward B. Vedder (1910-11) and its use in amebic dysentery was established clinically by Sir Leonard Rogers (1912).

Electrotherapy was modernized by Duchenne of Boulogne (1847-55), Robert Remak (1855-58), and Wilhelm Heinrich Erb (1882). Static electricity was first employed at Guy's Hospital by Thomas Addison, Golding Bird, and Sir William Gull (1837-52); and high-frequency currents were

introduced by Jacques-Arsène d'Arsonval (1887-92). Ionotherapy (galvanism), suggested by Edison in 1890, was introduced by Stéphan Leduc of Nantes in 1900. The x-rays, discovered by Wilhelm Conrad Roentgen in 1895, soon became a most reliable aid in diagnosis, and, in the hands of experts, a useful therapeutic measure, as also radium. Radium therapy, particularly ultra-penetrating radiation, which rendered its action potent for neoplasms, without damaging healthy tissues, was largely developed during 1906-19 by Henri Dominici (1867-1919), an Englishman of Corsican descent.

The hypodermic syringe was introduced in Europe by Francis Rynd (1845), Charles-Gabriel Pravaz (1851), and Alexander Wood (1855), and, in America, by Fordyce Barker (1856) and George Thomson Elliott (1858). Guido Baccelli introduced injections of quinine in malarial fever (1890) and of corrosive sublimate in syphilis (1894).

In 1895, Carlo Forlanini (1847-1918) introduced the treatment of phthisis by artificial pneumothorax.

Hydrotherapy was popularized by Max Joseph Oertel and the Silesian farmer, Vincenz Priessnitz (1799-1851), whose cold packs and barefoot promenades through dewy meadows were followed up by the Bavarian pastor Kneipp; in England, by James Manby Gully at Malvern (1842); and, in the United States, by Russell Thacher Trall (1844). Scientific hydrotherapy is especially associated with the names of Ernst Brand (1827-97), a practitioner at Stettin, who put Currie's forgotten cold-bath treatment of

typhoid fever upon a reliable working basis (1861-63); and Wilhelm Winternitz (1835-1917), director of the hydropathic establishment at Kaltenleutgeben.

Dietetics and regimen were advanced by William Banting (1797-1878), who in his Letter on Corpulence (1863), introduced the cure of obesity by the general reduction of food, including the exclusion of fats and carbohydrates, by Liebig, Wöhler, Beaumont, Mileschott, Pavy, Pavloff, Rubner, Chittenden, and other investigators of nutrition and metabolism, by Boas and Ewald, who introduced test-meals in digestive disorders, by Debove, who originated forced feeding in phthisis, and laterly by Carl von Noorden, who has made a special study of dietetics in disorders of metabolism and introduced the oatmeal diet in diabetes. Special treatments of heart disease were introduced by the laryngologist Max Joseph Oertel (1835-97). Theodor Schott (1852), at Nauheim, discovered the beneficient effect upon weak hearts of carbonated baths (1883) combined with slow gymnastics. The stomach-pump, for the removal of opium and other poisons (Monro *secundus*), was introduced simultaneously by Edward Jukes and Francis Bush, two English physicians, in 1822.

The scientific applications of hypnotism were principally studied by Charcot and his pupils at the Salpêtrière. The general tendency was away from hypnotic suggestion and toward mental and moral suasion or psychotherapy. Psychotherapy was put upon a working basis in such works as Paul Dubois' book on the moral treatment of psychoneuroses (1904).

The treatment of neurotic persons by suggestion became the word of ambition. It was applied by Rev. Elmwood Worcester at the Emanuel Church at Boston, by Émile Coué (1857-1926) (auto-suggestion).

Gymnastics for therapeutic purposes were introduced as "Swedish movements" by Per Henrik Ling (1776-1839) about 1813.

The founder of experimental hygiene was Max von Pettenkofer (1818-1901), of Lichtenheim, Bavaria, a pupil of Liebig and Bischoff, professor of "dietetic chemistry" at Munich, and, in 1853, professor of hygiene at the same university. In 1844 he introduced the well-known test for bile acids and in 1863-83, with Voit, he made his classical investigations of metabolism in respiration. He also demonstrated hippuric acid, creatin , and creatinin in the urine (1844). From 1855 on he devoted much attention to the etiology of cholera and typhoid fever, the spread of which he attributed to soil and soil-water. In spite of his somewhat arbitrary views, he all but rid the city of Munich of typhoid through the introduction of a proper system of drainage, a subject which frequently involved him in controversy with Virchow. Pettenkofer's most important contribution to experimental hygiene was his method of estimating carbon dioxide in air and water (1858).

Industrial hygiene was advanced by Sir Humphry Davy (1779-1829), who invented the well-known safety lamp for coal-miners (1815); and by Charles Turner Thackrah (1795-1833), of Leeds, one of Sir Astley Cooper's

pupils, who, in his treatise of 1832, first investigated brass-founders' ague, dust diseases, etc. In England, Sir Thomas Oliver has paid especial attention to dust diseases, miners' and live-wire accidents, and Leonard Hill investigated caisson disease (1912) and the general evils of stuffy atmosphere. Rudolf Virchow played an important part in the sanitation and sewage disposal of Berlin (1868-73) and was the originator of the modern movement for the hygiene and inspection of school-children (1869), which was ably carried forward by the labours of Edwin Chadwick (1871). School lunches for children were first established by Count Rumford, in 1792.

Public hygiene in England was specially advanced by the reports of Sir James Phillips Kay-Shuttleworth (1804-77) on the cotton workers of Manchester, and the training of pauper children (1841); and those of Thomas Southwood Smith (1788-1861), on the physical causes of preventable sickness and mortality among the poor (1838). The reports of the great lawyer sanitarian, Sir Edwin Chadwick (1800-90), on poor-law reform (1834-42), and the health of the labouring classes (1842), gave a definite objective to administrative acitivities. Chadwick may be said to have started public health in the United States. Sir John Simon (1816-1904), in his famous <u>Public Health Report</u> (1887) and <u>English Sanitary Institutions</u>, exerted great influence upon modern developments. The most important English treatise on hygiene is the manual of Edmund Alexander Parkes (1819-76), published in 1864, in the preparation of which he was aided by Lord Sidney Herbert (1810-61).

The epidemiologist, William Budd (1811-80) did the best English work of this time in infectious diseases. John Snow (1813-58), of York, a London medical graduate of 1844, first stated the theory that cholera is water-borne and taken into the system by the mouth (1849). He was a pioneer in anaesthesia, having delivered the Queen by chloroform in 1853 and 1857.

The leading medical statist of his time, in England, was William Farr (1807-83) who, in 1849, at the instance of Chadwick, gave up medical practice to enter the Registrar General's office. Some of his papers were collected in the volume Medical Statistics (1885).

In the United States, the leading prime-movers of public hygiene were Lemuel Shattuck (1793-1859) and that most accomplished scientific sanitarian of the later period, William Thompson Sedgwick (1855-1921), who, in collaboration with William Ripley Nichols and Thomas M. Drown, did most important work on sewage experimentation and purification of water.

Perhaps the earliest modern work on statistics was the famous Essay on the Principle of Population (1798) of Thomas Robert Malthus (1766-1834), of Guildford, England, which maintains that food-supply and birth-rate increase in arithmetical and geometrical ratios respectively, so that poverty is the natural result of increased population. Medical statistics were introduced by Louis (1835). The fallacies and various mathematical relations of vital statistics were studied by Rumsey (1875) and Farr (1885). Karl Pearson's work belongs to the 20th century. In America, his bio-

The [illegible], William Petty (1623-87) did the most important work at this time in [illegible]. [illegible] (16[illegible]) in 1693, a [illegible] of 1[illegible], [illegible] the [illegible] of [illegible]. He was a [illegible] in [illegible], [illegible] the [illegible] in 1[illegible] and 1[illegible].

The leading [illegible] of this time, in England, was [illegible] (17[illegible]) who, in 17[illegible], at the [illegible] of [illegible], [illegible]. Some of [illegible] were collected in the volume [illegible] (18[illegible]).

In the United States, the leading [illegible] of [illegible] were Lemuel Shattuck (1793-1859) and [illegible] of the latter period, Francis Amasa Walker (1840-1897), who, in collaboration with [illegible] and Thomas [illegible], did the most important work on census organization and [illegible] of [illegible].

Perhaps the earliest modern work in statistics was the famous Essay on the Principle of Population (1798) of Thomas Robert Malthus (1766-1834), of [illegible], England, which maintained that food-supply and births increase in arithmetical and geometrical ratio respectively, so that poverty is the natural result of increased population. [illegible] were introduced in [illegible] (18[illegible]). The [illegible] of vital statistics were studied by [illegible] (18[illegible]) and [illegible] (18[illegible]). [illegible] were [illegible] to the same [illegible]. In [illegible], the [illegible]-

metric methods have been applied with telling effect to vital and medical statistics by John S. Fulton, Charles B. Davenport and Raymond Pearl.

From the time of Haller, the study of medical history has been mainly in the hands of German and French writers. No work on a large scale has been attempted in Great Britain or America which will measure up with the performances of Haeser or Daremberg, unless it be Charles Creighton's History of Epidemics in Britain (1894).

The earliest German work of consequence in the 19th century was the Geschichte der Heilkunde of J. F. K. Hecker (1795-1850) which was followed by his collective monograph on the great epidemics of the Middle Ages (1865). The most scholarly and thoroughgoing medical history of the period was written by Heinrich Haeser (1811-84). Haeser's masterpiece was followed in Germany by the histories of Wunderlich (1859), Johann Hermann Baas (1876), Julius Pagel (1898, revised by Sudhoff 1901-6), Max Neuburger (1906), Paul Diepgen (1913-24), Sudhoff and Meyer-Steineg (1920), all works of solid and sterling merit. The study of medicine in relation to art was inaugurated by Virchow (1861), blocked out in detail by Marx (1861), placed upon its feet by the extensive work of Charcot and his pupils, and continued in such German works as Der Arzt (1900) by Hermann Peters. The history of medical education was treated by Theodor Puschmann (1844-99). Karl

Friedrich Heinrich Marx (1796-1877) of Göttingen, was the first modern to signalize the importance of Leonardo da Vinci in anatomy (1848). August Hirsch (1817-92) was author of the monumental Handbook of Historic-Geographic Pathology (1860-64); and Moritz Steinschneider (1817-1907), one of the greatest of medical archivists, who catalogued the Hebrew MSS. in the Bodleian (1857), made a list of 3014 early Jewish physicians (1896, completed by A. Freimann and L. Lewin, 1914-21). Julius Pagel (1851-1912), a busy practitioner of Berlin, wrote a history of medicine in 1897 and issued a capital biographical lexicon (1900), an encyclopaedic history of medicine (1901-6), and a useful medical chronology (1908). The work of Karl Sudhoff has a high place in the 20th century. The study of medical history was maintained at Vienna (1869-79) by Franz Romeo Seligmann (1808-92) and his successors, Theodor Puschmann (1844-99) and Max Neuburger.

Medical lexicography in the 19th century attained its stride, both in respect of solid performance and practical utility, in the wake of the gigantic accomplishment of Émile Littré (1801-81). The medical dictionary of Pierre-Hubert Nysten (1810) was, in its tenth edition (1855), entirely recast and enlarged by Littré and Charles Robin (1821-85), reaching its 21st edition in 1905.

Nysten was followed by a swarm of medical dictionaries in all languages. In point of scholarship, the best medical dictionary of American

origin is the four-volume work (1888-93) by Frank Pierce Foster (1841-1911).

As the modern period has been the great age of medical periodicals, so too it has been the age of medical biography. The first attempt to give an indexed author catalogue of an entire period, including the contents of periodicals, was the Medicinisches Schriftsteller-Lexicon (33 volumes, 1830-45) of the Danish surgeon, Carl Peter Callisen (1787-1866). The Library of the Surgeon-General's Office, at Washington, became, in time, the best medical library in the world through the energy, perseverance, and ability of its principal founder, John Shaw Billings (1838-1913). In 1876, Billings published a Specimen Fasciculus of a combined index catalogue of authors and subjects, and, in 1880, he issued the first volume of the Index Catalogue of the library in which he was assisted by Robert Fletcher (1823-1912), of Bristol, England. They also edited Index Medicus (1879-99).

THE TWENTIETH CENTURY:

THE BEGINNINGS OF ORGANIZED PREVENTIVE MEDICINE.

Primitive medicine, with its Egyptian and Oriental congener, is essentially a phase of anthropology. Greek medicine was science in the making, with Roman medicine as an offshoot, Byzantium as a coldstorage plant, and Islam as travelling agent. The best side of mediaeval medicine was the organization of hospitals, sick nursing, medical legislation and education; its reactionary tendencies are mainly of antiquarian interest. The Renaissance Period marks the birth of anatomy as a science, with a corresponding growth of surgery as a handicraft. The best of 17th century medicine was purely scientific. Eighteenth-century medicine was again retrograde in respect of system-making, but has to its credit the beginnings of pathology, refined diagnosis (Auenbrugger), experimental and physiological surgery (John Hunter), and acquires an added social interest in relation to the beginnings of preventive inoculation (Jenner), and the formulation of a definite programme of public hygiene (Frank). In the 19th century, the advancement of science was organized and scientific surgery was created. The interest of 20th century medicine is again social.

Nearly every important advance which has been made in recent medicine is prophylactic.

The tendency in all branches of recent science, even in zoölogy, sociology, therapeutics, internal medicine and surgery, has been to pass out of the descriptive into the experimental stage.

In 1865, the Augustinian monk, Gregor Johann Mendel (1822-84), abbot of Brünn, announced the results of certain experiments on hybridization in peas in the form of a law which has shed much light upon inheritance and the origin of species.

For at least thirty-five years this unique approximation, printed in an obscure periodical, remained unnoticed, but in 1900, Hugo de Vries (1848-   ), C. Correns, and E. Tschermak simultaneously confirmed Mendel's results in every respect, while Francis Galton had arrived at a statistical "law of heredity," based upon his observations on the pedigrees of Basset hounds (1897). From his experiments with the primrose <u>OEnothera Lamarckiana</u>, de Vries advanced his hypothesis of mutation (1901), or the abrupt or spontaneous origin of species from large discontinuous variations (mutations).

Thomas Hunt Morgan discovered the mechanisms of heredity, viz., that the Mendelian assortment of genes can be definitely allocated to the behaviour of the chromosomes. Connected with the counting of the chromosomes

in many plants and animals, the discovery of the accessory chromosomes by Henking (1890) and Montgomery (1898), their identification as the determinants of sex by Clarence Erwin McClung, is the complete elucidation of the mechanical factors involved in the determination of sex.

In place of the older picture of the struggle for existence, the future holds out the possibility of peaceful improvement by the gradual incorporation of characters beneficial to the race. Selection produces nothing new, but only more kinds of favoured individuals, a process which Morgan defines as creative evolution in the mechanical sense.

Recent studies lead to the conclusion that environment has little effect upon strongly individualized people, that the only effect of identical training upon miscellaneous groups of people is to widen the gulf between the bright and the dull, and that hereditary endowment will out.

Mendelian doctrine has been vastly forwarded by the new statistical science of biometrics, which is the special creation of Francis Galton and his brilliant pupil, Karl Pearson (1857-   ). Galton's Natural Inheritance (1889) introduced the statistical study of biological variation and inheritance. Pearson, an English barrister, now director of the Laboratory for National Eugenics, founded by Galton, has applied the higher mathematics in the most ingenious way to the solution of these problems and has created a rational school of iatromathematics.

Pearson has shown that, in the case of tuberculosis, it is not the disease but the diathesis which is inherited, not the seed but the soil;

that there is no neurotic inheritance from alcoholic parentage unless the stock itself be neurotic; and that a higher infantile death-rate implies the survival of a stronger and more enduring stock. There is a definite tendency in nature to handicap the first-born, who are weaker than subsequent offspring. Pearson maintains that "to make the first-born 50 per cent. instead of something less than 22 per cent. of the whole number of births," spells degeneracy.

According to Weismann's theory, acquired characters are not inherited, and the finest moral or mental traits in the parents will not benefit the offspring unless they have the right start in life. That conduct is re-action to stimuli, that morality is always an inhibition. For the weak, "the environment of today is the heredity of tomorrow". In 130 years, the five Jukes sisters produced 2094 descendants, 1258 living in 1915, of whom half were feeble-minded, shiftless and immoral, the other half mentally and emotionally normal. Estabrook's findings show that consanguineous marriages of defectives produce defectives.

Qualities may be inherited, but not their absence. As brown eyes are due to the presence, blue eyes to the absence, of a certain pigment, so brachydactyly (short fingers), presenile cataract, keratosis, xanthoma, hypotrichosis congenita, diabetes insipidus, night-blindness, and Huntington's chorea indicate the presence of certain factors in the germ-plasm which may interdict the union of two such abnormals; but albinism, deaf-mutism, retinitis pigmentosa, congenital imbecility, and the tendency to respiratory and neurotic disorders are due to an inherent lack of something

[illegible]

[illegible]

[illegible]

which may be supplemented by judicious cross-breeding with sound stock.

Nature's tendency is to revert to the mediocre level of the common stock.

In America, the most remarkable work done by the newer statistics is that of Raymond Pearl (1879). His conclusions are that the higher the density of population the lower the birth-rate, whence the population of any nation or community covering a given area will, in passing through the hunting, pastoral, agricultural and industrial stages, slowly increase up to the point of optimum relation between its density and subsistence resources and thereafter remain stationary (1925).

The trend of opinion indicates that while the mechanism of sex determination may be allocated to the accessory (XY) chromosomes signalized by McClung (1902), the ultimate process of sex differentiation is a much more complex matter.

Through developments such as these, biology is fast becoming a phase of general physiology. A striking illustration is the almost complete reorganization of anthropology by data drawn from physiology and pathology.

During the period 1850-1900, the solidist (cellular) pathology of Virchow dominated medicine, and, as in all Cnidian phases, consideration of the patient as a whole was lost in the pathological lesion or specimen as the _sedes morbi_. The rise of bacteriology merely transferred this dominance from cell to bacillus, but with the new sciences of serology and

endocrinology, the humoral pathology was revived and a new order of things obtained. With the World War, the doctrine of the Constitution took a sudden leap forward, and was further helped out by the development of Mendelian reasoning (genetics) and of endocrinology. In the view of Keith (1911), Crookshank (1912), and Paulsen (1920), race is the outward and visible sign of a definite equilibrium of endocrine secretions. Thus Allbutt's view of health as a diathesis (like scrofula or syphilis), the most useful cycle of the growing human organism, comes into its own and acquires new criteria from a study of the abnormal.

Should the constitution become basic for all branches of medicine, then, medicine (it is argued) becomes a vassal of anthropology. The inevitable pother about materialism and vitalism, started by Driesch, has latterly resolved itself into a reaction toward mysticism.

Jacques Loeb (1859-1924), head of the department of experimental biology in the Rockefeller Institute, devoted most of his life to the dynamic or chemodynamic study of living processes. In 1889, he caused the unfertilized eggs of the sea-urchin to develop into the swimming larvae by treating them with hypertonic sea water. He further showed that the ovum has a selective, specific activating influence on the spermatozoön. In 1916, Loeb stated that he had seven male parthenogenetic (fatherless) frogs (Rana pipiens), over a year old, produced by the Bataillon method of pricking the unfertilized egg.

Recent advances in anatomy turn almost entirely upon collateral investigations in physiology and pathology and sometimes upon new wrinkles in diagnosis and therapeutics.

The Altmeister of neurological anatomy was Ramón y Cajal (1852-1934). He produced his great Textura del Sistema Nervioso (1897-1904), comprising discoveries in all parts of the nervous system. Of his pupils, Pio del Rio Hortega devised a new staining method (1918) and discovered two new types of glia cells, viz., the mesodermal microglia (1919) and the ectodermal oligodendroglia.

The intracranial and intraspinal spaces containing the cerebrospinal fluid were investigated by Key and Retzius (1875), and the perivascular channels by Virchow (1851), Robin (1859), Duke (1894) and F.W. Mott (1910). Injection of trypan blue into the subarachnoid spaces by Goldmann (1913) and Woollard (1924) indicates that the mesothelial cells of the meningeal pathways may become macrophagic (meningocytes) and thus take on the rôle of scavengers.

Through the newer devices of micro-dissection, micro-injection, and intravital staining experimental cytology and tissue-cultivation have become going sciences.

By such means, the organized structures of the cell have been studied in minute detail, notably the nucleus and chromosomes (Kite and Chambers 1912-25), the invisible reticulum of Golgi (Gatensby 1919, Parat 1926),

and the invisible mitochondria. Harrison virtually started extra-vital cultivation of tissues by his proof of the outgrowth of nerve-fibres from ganglion cells (1910). Further improvements were the use of embryonic and chicken extract as growth promoters. Pure cultures were first obtained by the methods of A. Fischer (1922). Carrel kept a culture of fibroblasts growing for twelve years, and has observed the transformation of macrophages into cells resembling fibroblasts (1926).

Recent embryology illustrates both sides of the shield in the footless controversy about vitalism.

That the dorsal lip of the blastopore is the centre and starting point of cell differentiation and regulation of form in the embryo was first noted by Warren Lewis (1907). The formation of the corpus luteum was studied by Aschoff and pupils. The reticulo-endothelial system was adumbrated by Ranvier (1900) and by Metchnikoff in 1892-1901. Metchnikoff described phagocytosis in leukocytes in 1884, located the phagocytic function in the endothelial cells of blood-vessels (1892), the large mono-nuclears or "macrophages," the clasmatocytes (Ranvier), the lymphocytes and other fixed cells found in the spleen, lymph-nodes, connective tissue, neuroglia, and muscle-fibre.

From LaMettrie's <u>L'Homme Machine</u> (1748) to Loeb's <u>The Organism as a Whole</u> (1916) or the <u>Living Machinery</u> (1927) of A. V. Hill, the materialistic hypothesis has served to clarify concepts and to obliterate child-

ish mysticism.

The immense amount of investigation of the blood alone has created an independent science of haematology. The precursors were Nasse (1835), Andral (1843), and Virchow (1845). The leading later exponent was Arthur Pappenheim (1870-1916). Ehrlich (1898) classified the leukocytes; and stood out for the polyphyletic origin of the blood-corpuscles (from individual stem-cells). The mapping out of the recitulo-endothelial system by Aschoff and Landau (1913) and by Maximow (1924) is a phase of pathology.

The capillary circulation was first studied under the microscope by Leeuwenhoek (1686).

By 1883, Gaskell and Engelmann had proved that heart impulses are conducted by muscular pathways, and Stanley Kent (1892-3), discovered a narrow band of muscle, an embryonic rest between the auricles and ventricles, now called the auriculoventricular bundle of His, which acts as a bridge for contractile impulses, in accordance with Gaskell's theory that this phenomenon is due to the inherent contractility of cardiac muscles alone. Arthur Keith and M. Flack (1907) discovered the sino-auricular node. If the His bundle is destroyed in the dog, the contractile impulse will no longer pass from the auricle to the ventricles, and the latter will immediately assume their own autonomy, beating at a much slower rate, while the auricles, controlled by the vagus, will go on as before. This is the condition known as complete heart block or Stokes-Adams disease (1846).

Further light upon the intimate pathology of cardiac disturbance was thrown by the string galvanometer invented by Willem Einthoven (1860-1927). In 1878, Burdon Sanderson and Page made the first records of the heartbeat with the capillary electrometer. Gaskell's galvanometer studies of the electrical condition of the heart followed in 1881-2. In 1889, Augustus D. Waller (1856-1922) conceived the idea of measuring and figuring the variation of the action currents in the living heart by leading them off through electrodes placed upon the moist skin, connected with a galvanometer, the curves being obtained by photographing the movements produced by the mercury of a Lippmann electrometer, which was first done by Marey. The process was rendered accurate by the sensitive instrument of Einthoven.

The pioneer in the graphic study of cardiac arrhythmias was Sir James Mackenzie (1853-1925), who first made simultaneous records of the arterial and venous pulses to elucidate the clinical condition of the heart; and by raising the question, "How much work can the heart do?" concentrated future investigation upon the energetics of heart-muscle (1893-94). After practising at Burnley for nearly thirty years (1879-1907), he went up to London as consultant (1907). Mackenzie made his mark by his sincere, earnest attitude toward the sick and his sterling books on the pulse (1902), heart disease (1908), semeiology (1909), and angina pectoria (1923). He w one of the greatest of modern bedside physicians. He first investigated

the multiform arrhythmias, and differentiated "nodal rhythm" (1902-8), which Sir Thomas Lewis (1881-   ) defined as "auricular fibrillation". Mackenzie also demonstrated the wonderful efficiency of digitalis in auricular fibrillation (1910).

The study of the mechanism of tissue-oxidation and its automatic activator (glutathione) is of recent vintage. The jumping-off place was the classical paper of Sir Walter Fletcher and Gowland Hopkins showing the accumulation of lactic acid in the tissues (muscle) in the absence of oxygen. The discovery of ozone by C. F. Schönbein (1839) started the search for an activator of oxidation within the cell. The next steps were the isolation of glutathione in the pure state by Gowland Hopkins (1921), its exact formulation by his pupils (1923), and the synthesis of the racemic and optically active forms by Stewart and Tunnicliffe (1925).

Since the nervous mechanism of the automatic regulation of breathing was elucidated by Hering and Breuer (1868), Head (1889), and Scott (1908), recent study of respiration, as the convection of oxygen from the air to the tissues from the lungs by the blood, has been transferred from the lungs to the blood and the tissues. The regulation of respiration by the CO_2 concentration in arterial blood (i.e., rise = hyperpnea; fall = dyspnea - apnea) was shown by Haldane and Priestley (1905). That this in turn depends upon hydrogen-ion concentration of the blood was shown by Winterstein (1911)

and Hasselbalch (1912). The various apparatus employed in establishing the chemical regulation of respiration were devised by Haldane (1892-1918), Winterstein (1912), and Barcroft (1914).

In the 19th century, the only important contributions to the thermodynamics of muscular contraction were those of Helmholtz (1847-8) and Fick (1882) on heat production in muscle.

The suggestion of Gad that contraction is associated with lactic acid formation (1893) was brilliantly demonstrated by Fletcher and Hopkins (1907), and Fletcher had previously shown that the CO_2 output of excised muscle is accelerated by stimulation and onset of rigor mortis and increased in a bath of oxygen (1902). The problem was to show that muscle is a machine for converting chemical energy into mechanical work.

During the last forty years, a large number of Russian dissertations bearing upon digestion appeared, mainly by pupils of Pavloff, who did the most important work of his time, both upon digestion and the science of conditional reflexes.

The suceess of the early experiments of Ivan Petrovich Pavloff (1849- was due to his remarkable skill in operating on laboratory animals.

As early as 1852, Bidder and Schmidt had reported that the sight of food will produce a copious flow of gastric juice in a gastrostomized dog. Heidenhain failed to obtain this result. Pavloff improved the Heidenheim fistula by keeping the nerve-supply intact, and so standardized it for

modern procedure. Three sets of experiments were then possible for determining what Pavloff called "psychical secretion". By means of a special pancreatic fistula, Pavloff was also able to indicate that the secretory fibres of the pancreas are in the vagus nerve. In 1895, Dolinksy found that the introduction of acids into the duodenum causes a flow of pancreatic juice. Pavloff called the ordinary inherited reflexes (the vague "instincts" of the biologist) unconditional and such acquired responses as those of the burnt child or the beaten dog conditional.

Recent knowledge of postural reflexes started with Sherrington's observations of decerebrate rigidity (1898-1915).

The physiology of nutrition and metabolism has developed during the 20th century.

The starting point of recent knowledge of the vitamins or accessory food factors was an experiment of N. Lunin in Bunge's laboratory, showing that a synthetic milk diet lacks an unknown factor necessary for growth in animals (1880), which was confirmed by Gowland Hopkins' proof of the beneficial effect of a minute quantity of fresh milk upon an artificial growth-inhibiting diet in rats (1912). In 1882-6, Takaki eradicated beriberi from the Japanese Navy by an improved diet, which led to the experiments of C. Eijkman and Grijns on the effect of a monotone diet in producing avian beriberi (polyneuritis), and their discovery of an antineurotic substance in rice-husks and beans (1897-1906). In 1907, Fraser and Stanton treated experi-

mental polyneuritis successfully with alcoholic extract of rice polishings. Meanwhile, Casimir Funk had introduced the term "vitamine", and attempted to isolate it from the pericarp and postulated vitamin deficiency for beriberi, scurvy, pellagra, and rickets. In 1913-16 McCollum, Davis and Kennedy located a growth-producing substance in butter-fat and eggs (fat-soluble vitamin A) and a water-soluble vitamin B as the missing (anti-neuritic) factor in a beriberi-producing diet. A water-soluble vitamin C was postulated by Holst and Frölich for the missing factor in diets producing scurvy (1913). A.F. Hess showed it to be abundant in citrus fruits and tomatoes (1914-18). Cholesterin, the antirachitic substance extracted from cod-liver oil by Windaus (1917), was denominated vitamin D. In 1925, Hess and Weinstock (in May) simultaneously with Steenbock and Black (June) showed that the substance which acquires antirachitic properties upon irradiation is cholesterol (in animal products) or phytosterol (in plants). In a sense, vitamin D is, therefore, an effect of irradiation. A fat-soluble vitamin E, allocated to reproductive power and sterility, was postulated in wheat-germ and lettuce leaves by Evans and Bishop (1922-23).

Recent advances in knowledge of the metabolism of proteins are associated with the work of Emil Fischer on the hydrolysis of their amino-acid constituents. Nitrogen metabolism, as an expression of wear and tear in the tissues (nitrogen-increase) from muscular work, implies increase of

uric acid (Hamill and Schryer, 1906), purins (M'Leod, 1899, Burian, 1905) and creatin (Brown and Cathcart, 1909-21), but this holds good only on excessive exertion, as shown by the urine of Marathon runners. In carbohydrate metabolism, the work of Emil Fischer on the purins (1882-1906) and sugars (1884-1919) is important. The rôle of carbohydrates as protein-sparers and sources of muscular energy was shown even in starvation by Cathcart (1909). The discovery of insulin by Banting and Best (1922) threw new light on metabolism in diabetes. Metabolism of fat (synthesis from carbohydrates and storage) was investigated by Lebedev (1882) and Ida Smedley (1912-13). Nucleic acid metabolism was investigated by Levene (1912-25); and purin metabolism by Hunter and Givens. The colorimetric methods of blood analysis were devised by Otto Folin and Wu (1919-22).

The new science of endocrinology, although rooted in the prehistoric past, is virtually a creation of the 20th century.

In 1902, Sir William Maddock Bayliss (1860-1924) and Ernest H. Starling announced to the Royal Society that the secretion of pancreatic juice which is caused by introduction of acid into the duodenum is not a local reflex, but is produced by a substance (secretin) thrown out from the intestinal mucous membrane under the influence of the acid and carried thence by the blood-stream to the glands, as shown by experiment. Pavloff subsequently discovered enterokinase and Bayliss and Starling developed their theory of the chemical control of the body by means of "hormones" or

chemical messengers, which pass from the organs and glands by the blood-channels to the other parts of the body. Operative surgery has played the most important part in working out the physiology and pathology of these glands.

The starting-point of the doctrine of internal secretions was Claude Bernard's work on the glycogenic function (1848-57) and Addison's account of disease of the suprarenal capsules (1849-55). The former was thrown into striking relief through von Mering and Minkowski's experimental production of diabetes by excision of the pancreas (1889). In 1894-95, Oliver and Schäfer found that injection of the watery extract of the suprarenal glands into the blood produced marked slowing of the heart and rise of blood-pressure. The description of hyperthyroidism or exophthalmic goitre by Parry (1786), Graves (1835), and Basedow (1840), and of hypothyroidism or myxedema by Curling (1850), Gull (1875) and Ord (1877) emphasized the mysterious importance of the thyroid gland. Murray (1891) and Howitz (1892) treated myxedema with thyroid extract with very successful results. The isolation of iodothyrin by Baumann, in 1896, indicated its relation to iodine metabolism. Thyroxin, isolated by E. C. Kendall (1914), is a stirring activator of metabolism and probably the hormone of the gland. The parathyroid glands were described by Ivar Sandström in 1880 and, in 1891, Eugène Gley showed that negative thyroidectomies in certain animals would be rendered speedily fatal if the four parathyroids were also removed. It was shown

that tetany will be produced if a transplanted gland is removed and <u>per contra</u> that the tetanic spasms will disappear after injecting the saline extract of the gland or after parathyroid feeding or transplantation. W. G. MacCallum and C. Voegtlin showed that exhibition of calcium salts will remove tetany, even in man, which seems to connect the parathyroids with calcium metabolism. A parathyroid hormone was isolated by I. B. Collip in 1926. The function of the thymus gland was first investigated by Friedleben (1858), but the effects of its excision or of the injection of its extracts are still obscure. Robert Battey excised the normal healthy ovaries for the relief of neurotic and non-menstruating women (1872). The rationale of this operation, in relation to a supposed internal secretion from a specialized set of ovarian cells, has since been justified, particularly in osteomalacia. In the last thirty years, attention has centred upon the pituitary body. Nicholas Paulesco of Bucharest was the first to point out that removal of the anterior lobe is fatal and removal of the posterior lobe negative (1908). Meanwhile Mohr had described obesity with pituitary tumour (1840), Pierre Marie had shown the relation of the pituitary to acromegaly (macrosomia) and gigantism (1886), Fröhlich described pituitary tumour with obesity and sexual infantism (1901), and Harvey Cushing and his associates at the Johns Hopkins Hospital actually produced an experimental pathologic reversion to the Fröhlich syndrome by partial excision of the anterior lobe in adult dogs. Simmonds des-

cribed pituitary dwarfism (anterior lobe deficiency 1914-18), Hutchinson and Gilford, progeria (1904), and H.M. Evans showed the effect of anterior lobe extract upon interruption or prevention of the oestrus. Cushing has shown that the anterior lobe secretion influences normal growth and sexual development, while the posterior lobe has to do with metabolism of carbohydrates and fats, the high tolerance of sugars in posterior lobe insufficiency yielding to treatment with pituitary extract. Cushing and his pupils have also shown the relation of the hypophysis to diabetes insipidus (1912) and hibernation (1913). The ideas of Gaskell, Langley, and Sherrington as to the opposing functions of the two "autonomics" of the sympathetic system in the elucidation of the complex mechanism of physiological equilibrium and of visceral neurology postulate two opposing diathetic conditions vagotonus and sympathicotonus. Adrenalin is the hormon governing the sympathetic autonomic.

The most eminent physiological chemist of recent times was Emil Fischer (1852-1919). He discovered, isolated and formulated a host of new substances, devised quantitative methods for isolating amino-acids, and demonstrated an amido (NH_2) nucleus common to all the proteins. His investigations of the enzymes (1884-1919) show that they are specific in action (1894-5), affecting only certain chemical substances. A brilliant stroke of genius was Fischer's deliberate attempt to produce a reliable hypnotic, ending in the synthesis of veronal (1904).

Emil Abderhalden (1877-   ) worked on the integration and disintegration of albuminoids and nucleic acids in the animal body, the protective ferments (1909-12), the metabolism of the cell (1911), the synthesis of its Bausteine (1912), and the synthesis of artificial food-stuffs, as tried out experimentally upon animals. His contributions to the technic and methodology of biochemistry are of vast extent.

Gustav Embden (1874-   ) worked on metabolism of fats (1906-8) and carbohydrates (1910-13); Otto Meyerhof (1884-   ) on the chemistry of cell and muscle (1912-24); Adolf Windaus (1876-   ), of Göttingen on the constitution of cholesterol,(1904-23); Sir Gowland Hopkins on glutathione, 1921; Henry Drysdale Dakin (1880-   ) on carbohydrate metabolism, 1912; Francis Gano Benedict on metabolism in diabetes; Otto Folin, author of the well-known method of estimating creatin and creatinin in the urine (1904), on blood analysis; Donald B. Van Slyke (1883-   ) on estimation of amino-acids; and Elmer Verner McCollum (1879-   ) on growth, nutrition requirements, 1911-25.

The leading spirit of recent pathology is Ludwig Aschoff (1866-   ). A great systematist and philosopher, Aschoff strove to bring order and system into the bewildering complex of pathological reasoning. His synthesis of the reticulo-endothelial system (1913-24) resembles Waldeyer's summation of the neuron theory (1891) in its orderly tendency. He set the pace and posed the problems for German pathological work on war material.

Among the outstanding pathologists of the newer trend are: Felix Marchand (1846-1928), of Leipzig, memorable for his work on inflammation and healing of wounds (1890-1921); Paul Grawitz (1850-), professor at Greifswald (aberrant hypernephroma, 1883-4); James Ewing (1866-), of Pittsburgh (clinical pathology of blood, 1900-13; neoplastic diseases, 1919); Frank Burr Mallory (1862), of Cleveland, Ohio (endothelial leukocytes, 1898-26; histopathology, 1914); Aldred Scott Warthin (1866-), of Greensburg, Indiana (pathology of haemolymph glands, haematopoietic system); William George MacCallum (1874) (pancreatic diabetes, 1909); Simeon Burt Wolbach (1880-) (Rocky Mountain fever, typhus fever, influenza); Horst Oertel (1873-), Oscar Klotz (1878-) (arteriosclerosis, 1912; yellow fever 1928); Dorothy Reed (Hodgkin's disease, 1902), and Maude E. Abbott (malformations of heart, 1908-27). This renaissance of pathology is in striking contrast with the deplorable status during the World War, when few surgeons competent to conduct a postmortem section could be found.

Of late years there has been an amazing increase in the literature of psychology, now an analogue of the general physiology of Claude Bernard. Comparative psychology turns mainly upon Loeb's theory of tropisms in the lower forms (or the views of those who, like H.S. Jennings, oppose it) and the study of "behaviour" in the higher animals (Watson). Among the leaders in morbid psychology is Pierre Janet (1859-), professor at the Collège

de France. In 1905-8, Alfred Binet (1857-1911) and Th. Simon introduced a series of graded tests for mental retardation. There has been an intensive study of sexual psychology. Recent thinking has been revolutionized by the revelation of the part played by suppressed or repressed sexuality in the development of neurotic conditions, the special achievement of Sigmund Freud (1856-1939), of Freiburg, in Moravia. Freud also developed the theory of the psychic significance of dreams. He believed that there is a rigid determinism of psychical effects and that many complex mental processes never attain to consciousness and can be elicited only by a long process of "psychoanalysis". In his view, the basis of all sexual neuroses is the child's unconscious attachment to its parents, sometimes with hostility to the parent of the same sex. The real interest of Freud is his profound insight into the workings of primitive mentality, or what Jelliffe calls "paleopsychology" (the historic past of the individual psyche)

Alfred Adler (1870-1937), of Vienna, stressed organic inferiority, sexual or other, as a prominent cause of neuroses (the inferiority complex, 1907). In this class of neurotics (Goethe's <u>incompletae</u>), the sexual or other inadequacy is set off by a constant subconscious effort to assert and attain superiority (Nietzsche's "will to power"). The strong deliberately choose plainness and simplicity. The neurotic, victimized by the "as if" tendency of Vahinger, acts on the assumption that he is strong, projects his own faults on to others, affects disdain, is fertile in reasons for failure, and combines a general faultfinding spirit with a self-imposed

nimbus.

The behaviourist (comparative) psychology interprets mentality in terms of reaction to environment.

In the earlier period of Parasitology and Chemotherapy, Agostino Bassi had found the pathogenic organism (Botrytis Bassiana) of silkworm diseas or muscardine (1837), Schönlein, the achorion of favus (1839), Donné, the Trypanosoma sanguinis in frogs, Davaine, the Cercomonas hominis (1857), Malmstem, the Balantidium coli (1857), Lambl, the Giardia intestinalis (1857) whi Leeuwenhoek viewed sans le savoir in 1681. Leuckart extended the general law of intermediary hosts to the Arthropoda and under his direction Fedschenk determined the life-history of Filaria medinensis in Cyclops (1869). This led to the studies of Patrick Manson on the development of Filaria bancrofti in mosquitoes (1879), Smith and Kilborne on ticks and Texas fever (1888), Bruce on the tsetse fly and nagana (1894), Ronald Ross on malaria and mosquitoes (1889-98), Finlay (1881), Walter Reed and his associates (1900) on yellow fever and Stegomyia. The greatest single monograph on dysentery is that of J. J. Woodward (1879), who saw the Loesch ameba, but did not sense its significance. Koch (1883) and Kartulis (1886-91) in Egypt, found amebae to be invariably present in dysenteric postmortems, even of liver abscess, and differentiated between endemic dysentery due to amebae, and epidemic dysentery due to bacteria. The term "Amebic dysentery" was introduced by W. T. Councilman and H. A. Lafleur at the Johns Hopkins Hospital (1891), two types of parasites being recognized, the harmless

Amaeba coli, and the pathogenic Amaeba dysenteriae. These views were confirmed by Casagrandi and Barbagallo (1897), and particularly by Fritz Schaudinn, who styled the harmless form Entamaeba coli and the pathogenic form Entamaeba histolytica. Meanwhile the question of bacillary dysentery had been settled by the discovery of bacilli by Shiga in Japan (1898), Kruse in Germany (1900), Flexner (1900), Strong and Musgrave at Manila (1900), and the Y-bacillus of Hiss and Russell (1903) in America.

The symptoms of hook-worm infection were vaguely outlined in the Egyptian papyri, and for centuries the disease was variously known as Egyptian or tropical chlorosis, miner's or bricklayer's anemia, and St. Gothard tunnel disease. The parasite was described as Anchylostoma duodenale by Angelo Dubini (1843). Charles Wardell Stiles (1867-), of Spring Valley, New York, discovered that the parasite of the American infections is a new species which he called Uncinaria americana (1902) and later Necator americanus. Stiles, who had already made his reputation in parasitology by his work on revision of species and nomenclature, has since devoted himself to the task of exterminating the disease in the South, in connection with the Rockefeller Commission. In 1898, Arthur Looss (1861-1923) made the important discovery that the hookworm larva can penetrate the skin, reaching the intestines by a devious route, and this fact has enabled Stiles and Ashford to devise effective means of prophylaxis among rural populations. Pellagra, which has latterly been identified in American, has been closely

studied by Lombroso, Théophile Roussel, Sambon and others in Europe, and by James W. Babcock, Claude H. Lavinder, Joseph Goldberger and his associates in the U.S. Public Service. It is now classed among the deficiency diseases. Joseph Goldberger and his associates have demonstrated its experimental production in patients subsisting upon a faulty diet.

In 1911, Laveran's malaraial parasite was obtained in pure cultures in vitro by Charles C. Bass, of New Orleans. Howard Taylor Ricketts (1870-1910), of Findlay, Ohio, a pupil of Hektoen, discovered that the Rocky Mountain spotted fever is transmitted by the wood-tick (Dermacentor occidentalis) in 1907, and (with R.M. Wilder) that Mexican typhus (tabardillo) is transmitted by the body-louse. The disease discovered by Nathan E. Brill in New York in 1910 was shown by Goldberger and Anderson to be a mild form of typhus.

The trypanosomes discovered by David Grüby (1809-98) in the frog (1843) and by Lewis in the rat (1878) were non-pathogenic, but a new interest in these organisms was awakened when Griffith Evans (1880) discovered in India that Surra, a disease of horses, mules, camels and cattle, is caused by a variety which was afterwards named by Steel and Crookshank, Trypanosoma evansi (1885-86). It is of record that the African traveller, David Livingstone, gave an accurate account of the tsetse fly disease in his Missionary Travels (1858). In 1894, Sir David Bruce (1855-1931) found that the tsetse fly disease or nagana of Zululand is due to the Trypanosoma

brucei (Plimmer and Bradford, 1899), which he proved experimentally to be conveyed from the blood of big game animals to cattle and horses by this fly (Glossina morsitans). In the same year (1894) Rouget discovered T. equiperdum (Doflein, 1901), as the cause of dourine or mal du coït in horses; in 1901 Elmassian found T. equinum (Vosges, 1902) as the cause of mal de caderas in South American dogs and horses; Theiler (1902) found T. theileri (Bruce, 1902) in the bovine gall-sickness or galziekte of South Africa. The most important find, however, was that of T. gambiense in the blood of man by J. Everett Dutton (1901), which was afterwards seen by Aldo Castellani in the cerebrospinal fluid and blood of five cases of African sleeping sickness (1903). It was then shown by Bruce and Nabarro, of the Royal Society Commission, that the tsetse fly is the vector of the disease. A Brazilian variety of human trypanosomiasis, due to T. cruzi and transmitted by a bug (Conorhinus sanguisuga), was described by Carlo Chagas (1909). Another remarkable organism was found in 1900 by Sir William Boog Leishman (1865-1926), in a postmortem film from a case of fever at Dum Dum. Major C. Donovan found the same bodies in blood taken in life from splenic punctures. In July, 1904, Leonard Rogers announced the development of these parasites into flagellates and, in 1906-7, Walter Scott Patton described their development into flagellates in the bedbug. In 1903, James Homer Wright found similar parasites (Leishmania tropica) in Oriental endemic ulcers, and Charles Nicolle found Leishmania infantum in infantile kala-azar (1908). In 1888, Victor Babes (1854-1926), a

Roumanian physician, discovered a small protozoön in the blood of sheep suffering from an epizoötic disease called carceag, and the genus was called in his honour Babesia by Starcovici (1893), the term Piroplasma having been proposed by Patton (1895). In the same year Theobald Smith (1859-   ) found the organism, Pyrosoma bigeminum, in Texas fever, which, with F.L. Kilborne, he demonstrated to be transmitted by the tick. This was the first demonstration, after Manson's, of the transmission of infection by a blood-sucking insect. In 1903, cell inclusions, staining deeply with methylene-blue-eosin, were found in the central nervous system in hydrophobia by Adelchi Negri (1876-1912) and a culture of these was made by Hideyo Noguchi in 1913. The spirochete or spirillum of relapsing fever, discovered by one of Virchow's assistants, Otto Obermeier (1843-73), in 1873, was to open out the most important phase of parasitic diseases yet known, viz., the conquest of syphilis by Schaudinn, Wassermann and Ehrlich. In 1903, the spirochete of African relapsing fever (tick fever) was discovered independently by Nabarro, Ross and Milne in Uganda and by Dutton and Todd in the Congo and was called Spirochaete duttoni, in honour of Dutton, who died from the disease after he had proved its transmission by a tick (Ornithodorus moubata). The spirochete of the American variety of relapsing fever was discovered by Frederick G. Novy (1907). In 1903, Marchoux and Salimbeni proved that a Brazilian spirochaetosis of domestic fowls is transmitted by the tick Argas persicus.

Alphonse Laveran (1845-1922), of Paris, discovered the parasites of malarial fever (November 6, 1880).

Sir Ronald Ross (1857-   ), of the Indian Medical Service (1881-99), located the anopheles mosquito as the vector of malarial fever, discovered the Laveran plasmodia in the stomach wall of Anopheles which had fed upon the blood of malarial patients (1897), proved that the spores of the parasites are concentrated in the salivary gland of the insect (1898). In mathematics, he has applied the theory of probabilities to the statistical prognosis of epidemics.

Important advances in protozoölogy were made by Fritz Schaudinn (1871-1906), whose first important contribution to medicine was the differentiation between the harmless Entamoeba coli and the pathogenic Entamoeba histolytica (1903). He confirmed the work of Ross and Grassi upon the malarial parasite, identifying Plasmodium vivax (Grassi and Feletti) as the cause of tertian fever (1902) and also confirmed Looss's demonstration of hook-worm infection through the skin (1904).

In May, 1905, working with Erich Hoffmann, Schaudinn crowned his life-work by the discovery of the Spirochaeta pallida of syphilis.

The first steps in the conquest of syphilis had thus been made by professional zoölogists, Metchnikoff and Schaudinn.

Paul Ehrlich (1854-1915), of Strehlen, Silesia, was but an indifferent

student, occupying his time mainly with experiments on dye-stuffs and tissue staining, but the results of his labours soon appeared in his improved methods of drying and fixing blood-smears by heat, his triacid stain, his discovery of the mast cells, his division of the white blood-corpuscles into neutrophilic, basophilic and oxyphilic, his fuchsin stain for tubercle bacilli, and his diazo-reaction of the urine. He was the pioneer of Farbenanalyse or the microchemical action of the tissues to dye-stuffs (1885-91). Ehrlich assumed that the living protoplasmic molecule consists of a stable nucleus and unstable peripheral side-chains or chemo-receptors, which enable it to combine chemically with food substances and neutralize toxins or other poisons by throwing out detached side-chains into the blood. It proved to be a valuable "heuristic principle" in developing the science of immunity and serum reactions. Thus, August von Wassermann (1866-1925) did not hesitate to affirm that without it he could never have hit upon the special and reliable haemolytic diagnosis of syphilis with which his name is associated and which was discovered one year after Schaudinn had found the parasite of the disease (1906). The original Wassermann reaction has been much followed by such ingenious modifications and checks as the flocculation reactions of Meinicke (1911), Vernes (1917-19), Sachs-Georgi (1918) and Dold (1921), the sigma reaction of Dreyer and Ward (1921) and the simple direct sensitive test of R.L. Kahn. In attempting to treat trypanosomiasis in mice with certain specific dyes, Ehrlich found that if the dose were too

small to completely sterilize the animal of the parasite, a race of trypanosomes could be bred which proved permanently "fast" or resistant to the effects of the drug. This power of parasites proved to be the weak point in their final result, "606", or salvarsan. Salvarsan, which was first tried by Ehrlich's Japanese assistant, S. Hata (1910), is a valuable prophylactic. The merits of "neo-salvarsan" ("914" in Ehrlich experimental series) were greater. Salvarsan is, however, an ideal therapia sterilisans in the case of Treponema pertenue, the parasite of yaws. Ehrlich was the founder of haematology. He classified the leucocytes according to the presence or absence of granules, differentiated the leukemias, described polychromatophilia, distinguished between normoblasts and megablasts, lymphoid and myeloid tissues, showed that leucocytosis is a function of bone-marrow, studied aplastic anemia and laid the foundation for the study of the specific reactions of cells to various infections and stimuli. Of the other features of Ehrlich's scientific work, his proof that animals can be quantitatively immunized against vegetable poisons like abrin and ricin; his improvement of Behring's diphtheria antitoxin; and his vast researches in the whole field of serology and immunity can only be mentioned.

The trend of recent medicine from the bacterial theory of disease toward the biochemical is strongly marked in Ehrlich's work.

Jules Bordet, Director of the Institut Pasteur de Brabant (Brussels), has been a great pioneer in the theory of serology and immunity reactions.

He discovered bacterial haemolysis (1898), and, with Octave Gengou, fixation of the complement (1900-01), and the specific bacillus of whooping-cough. He assumes that the toxin is neutralized by an antitoxin through absorption, comparable with that shown by a fabric in taking up dyes. Similarly, he assumes a substance sensibilisatrice in antitoxic sera which sensitizes the red blood-corpuscles or bacteria to the action of the alexins, as a mordant does for a dye-stuff.

Among the advances in serology of striking interest are Quincke's lumbar puncture (1909) in cytodiagnosis, the discovery of agglutination by Bordet (1895) and Gruber (1896) and its application to the diagnosis of typhoid fever by Widal and Sicard (1896); the diagnostic use of tuberculin by the conjunctival reactions of Albert Calmette (1907) and Alfred Wolff-Eisner (1907), and the cutaneous reactions of Clemens van Pirquet (1907); and Sir Almroth Wright's preventive inoculation against typhoid fever by dead cultures of the bacillus.

Bacteriology is now a highly organized science of immense practical efficiency, and two of its phases, environmental bacteriology and personal bacteriology, are basic in sanitation. In 1917 and 1920, C.-E.-A. Winslow and other committeemen of the Society of American Bacteriologists issued two exhaustive reports on classification, culminating in a Manual of Determinative Bacteriology by David H. Bergey and others (1923). During the second half of the 19th century plant pathology had been mainly phytopatho-

logy. To Edwin F. Smith (1854-1927), of Gilbert's Mills, New York, we owe the conclusive demonstration of the existence of bacterial diseases in plants. Meanwhile, through the interesting investigations of Ashford on tropical sprue (1908-14) and of Castellani on pathogenic moulds (1905-27), medical mycology was beginning to take its place in the science of communicable diseases. The Pasteurella group is responsible for haemorrhagic septicemia in fowls (Perronciti, 1879; Pasteur, 1880), rabbits (Davaine, 1872; Koch 1878), cattle (Kitt, 1885), swine (Loeffler & Schütz, 1886), and bubonic plague bacillus (Kitasato & Yersin, 1894). Scarlatina has been interpreted as a streptococcic infection of the throat by George F. and Gladys H. Dick (1923), who have produced a viable test for susceptibility by intracutaneous injection of the toxin in susceptibles (1924), immunization by inoculation of increasing skin test doses of the toxin (1924) and an antitoxic serum which can be used for prophylaxis or treatment (1924-25). The mycobacteria include the pathogens of tuberculosis in man (Koch, 1884); and the bacilli of leprosy (Neisser, 1879; Hansen, 1880). To the Clostridia belong Pasteur's Vibrion septique (1861), the first pathogenic anaërobe to be described and now recognized as the causative agent of malignant edema (C. septicum). The Haemophilus group includes the influenza bacillus (Pfeiffer 1892-93), the Haemophilus haemolyticus (Pritchett & Stillman, 1919), the bacillus of whooping-cough (Bordet & Gengou, 1906), and the Koch-Weeks bacillus (1887). The typing of pneu-

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mococci by Dochez, Gillespie, and Avery (1913-16) has thrown much light upon their relative virulence. Thus, bacteriological diagnosis tends to ultrarefinement.

The bactericidal action of the blood was noted by John Hunter and demonstrated by Fodor (1887), Nuttall (1888), Buchner (alexins, 1890-95), von Behring and Nissen (1890). Pfeiffer discovered bacteriolysis of cholera bacilli in the peritoneal cavity. Antitoxins were discovered by von Behring and Kitasato (1890). Toxin-antitoxin mixtures were investigated in diphtheria by Ehrlich and Knorr (1895-7) and by Bordet (1899). Bacterial agglutinins were discovered by Gruber and Durham (1896), applied to typhoid diagnosis by Widal (1896) and shown to be absorbed from sera by bacteria (Castellani, 1902). Precipitins were discovered by R. Kraus (1898). Anaphylaxis, known to Jenner and Magendie, was investigated by Richet (1902-9), Theobald Smith (1903), Rosenau and Anderson (1906-7) and Otto (1906-7); sensitization to foreign proteins by Hericourt and Richet (1898), von Pirquet and Schick (allergy, 1903); serum sickness by Pirquet (1905); the Arthus phenomenon in secondary injections of horse-serum by M. Arthus (1903-6). Preventive vaccination with dead cultures was demonstrated by Brieger, Kitasato and Wassermann (1892) and Pfeiffer (1896). The theory of local immunity in the cells and tissues, without the intervention of antibodies was developed by Alexander Besredka (1925), who introduced sensi-

tized vaccines (1913) and preventive inoculation against phthisis by B.C.G. or avirulent bovine bacillus vaccines (Bacillus-Calmette-Guérin, 1921-7).

Transmissible lysis of bacteria was discovered by F. W. Twort (1915) and F. d'Herelle (bacteriophagy, 1917). D'Herelle postulates a self-reproducing bacteriophage (1918), Twort a pre-cellular (pre-bacterial) ultra-scopic, filter passing virus. The starting point of the doctrine of filterable viruses was the discovery of Loeffler and Frosch that the inoculable virus of foot-and-mouth disease will pass through the finest filters (1898), which had already been shown for the mosaic disease of tobacco by Ivanovski (1892) and Beijerinck (1893), with eventual cultivation of the virus by Olitsky (1925).

It is a remarkable fact that many of the indeterminate diseases allocated to ultrascopic viruses are associated variously with cell inclusions of the type observed by Guarnieri (1892) or Negri (1903), bacteroid dots or chlamydozoa (Prowazek, 1907-8), Strongyloplasmata (Lipschütz, 1913) or the bacteria-like Rickettsia (1906-11).

Tropical medicine had its authentic start with the organization of the Indian Medical Service of the British Army (1764). The real prime mover was Sir Patrick Manson.

The beginnings were the observations on parasites in Egyptian papyri and Babylonian baked bricks, the clinical data on leprosy, malaria, plague and diphtheria (<u>ulcera Syriaca</u>) in Hippocrates, Aretaeus, the Bible and the

Talmud, the Hindu notations on mosquitoes (Malaria), and rats (plague). The introduction of cinchona bark (1638-70) was the _point d'appui_ of the clinical studies of Sydenham, Morton, Lancisi and Torti on malarial fever. The service of the U.S. Army Medical Department in the Philippines (1900) and Antilles (1900) was distinguished by a rapid output of effective work, culminating in the sanitation of the Panama Canal Zone. In Japan, Ogata first differentiated infantile beriberi (1888), from the adult type. In the Dutch East Indies, Christian Eijkman (1858-) was remarkable for his investigations on beriberi (1897-1906). Among the Germans, Theodor Bilharz (_Schistosoma haematobium_, 1852), and H.B. Scheube (1851-) did much to advance parasitology in Japan. In Italy, the names of Baccelli, Golgi, Marchiafava, Celli, Grassi, Bignami are associated with malarial fever, and Aldo Castellani with the parasites of sleeping sickness (1903) and yaws (1905) and the best historical treatise on tropical medicine (1910).

Sir Patrick Manson (1844-1922) entered the Chinese Imperial Maritime Customs Service under Sir Robert Hart. In 1872, he described tinea nigra. In 1877, he found filaria in elephantiasis and in 1878 discovered the transmission of _Filaria bancrofti_ by the Culex mosquito. In 1880, simultaneously with Baelz, he found Paragonimus Westermanni in human sputum. He was the first after Hillary (1766) to give a correct description of tropical sprue (1880). He discovered _Sparaganum mansoni_ (1883), _Filaria hominis_ (1891), the larval stage of _Filaria loa_ (1891), its rôle in Calabar swelling (1893) and

the eggs of Schistosomum mansoni (1903). He was the first to maintain that blackwater (haemoglobinuric) fever is distinct from malaria (1893) saw Trypanosoma gambiense before Ford (1900), performed the classical experiment of transmitting tertian malarial fever by an anopheline upon his own son, and was the inspirer and mentor of Ronald Ross.

In 1898, Manson started the London School of Tropical Medicine in a small house near the Albert Docks. He was well described by Blanchard as "the father of tropical medicine."

In 1906, Lieut-Col. Robert McCarrison (1878-   ) described the three-day fever endemic in Upper India since 1895. He is further distinguished by his investigations of the infectious endemic goitre of Kashmir (1913), the thyroid gland (1917), beriberi and other deficiency diseases (1921-4), particularly the remarkable degenerative changes in the viscera and general lowering of digestive capacity produced by vitamin B- or C-deficiency anterior to beriberi or scurvy.

George M. Sternberg (1838-1915), who isolated the diplococcus of pneumonia simultaneously with Pasteur (1880), though the incrimination of "Bacillus X" in yellow fever is a negative find, cleared the ground for later investigators.

Major Walter Reed (1851-1902) was detailed as the head of a Board, including James Carroll, Aristide Agramonte and Jesse W. Lazear, to study yellow fever in Cuba. Carlos Finlay (1833-1915) had already advanced the theory that the disease is transmitted by the stegomyia mosquito (1881).

Reed and his associates soon disposed of Sanarelli's bacillus (identical with the Bacillus X of Sternberg) and proceeded at once to attack the problem of transmission by mosquitoes. Carroll was the first to submit to mosquito inoculation and came through an attack of yellow fever successfully. Lazear died from the effects of an accidental mosquito-bite. Major William C. Gorgas (1854-1920), as chief sanitary officer of Havana, Cuba, began to screen yellow fever patients and destroy mosquitos, and, in three months, Havana was freed from the disease for the first time in 150 years. In connection with the work on the Panama Canal, Gorgas freed that part of the Isthmus not only from yellow fever, but from all dangerous infections. The investigations of typhoid fever incidence in camp during the Spanish-American War (1898), by Walter Reed, Victor C. Vaughan and Edward O. Shakespeare demonstrated the transmission of the disease by flies.

During the American occupation of Porto Rico, Colonel Bailey K. Ashford discovered hook-worm infection in the island (1900) and eradicated the disease, found sprue in Porto Rico (1908), identified Monilia psilosis (1914) and founded the Institute of Tropical Medicine at San Juan (1917). Colonel Charles F. Craig (1872-   ) demonstrated the existence of malaria carriers. He is also the author of extensive monographs on the malarial fevers (1901, 1909), the parasitic amaebae in man (1911) and of recent work on haemolysins. Major Frederick F. Russell, in 1909, began the huge experiment of vaccinating

the United States Army against typhoid fever. Colonel Edward B. Vedder (1878-), of New York City, has made important studies in beriberi as a deficiency disease. In 1916, Major George B. Foster made an important investigation of the causation of common colds by a filterable virus. In 1925, Colonel Joseph F. Siler and Majors Milton W. Hall and Arthur P. Hitches demonstrated (in 47 cases) the transmission of dengue by Aëdes aegypti, thus nullifying the long accepted belief that Culex fatigans is the vector.

Recent surgery undoubtedly owes most to Wilhelm Konrad Röntgen (1845-1922). The applications of Röntgenology to surgery and medicine were developed with amazing rapidity and in less than twenty years the new science was on a firmer footing than most. Röntgentherapy started with the discovery of the possibility of epilation in naevus pilosus and hypertrichosis by Leopold Freund of Vienna (1896) and the next five years were devoted to empirical therapy of cutaneous lesions, notably lupus and favus. The new period was ushered in by G. Holzknecht and Kienböch, who introduced scientific dosage (1900-2); and Albers-Schönberg who invented the compression diaphragm (1902-3), which intensified the object by cutting out secondary rays. Senn applied the x-rays to the treatment of leukemia (1902-3). Following Beclère's work on deep therapy in tuberculous lymphoma, it was used effectively in the treatment of sugical tuberculosis (bones and joints). The introduction of such new devices as the Coolidge tube (1913) and the Potter-Bucky diaghragm (1913-24) mark the beginning of a new period.

The discovery of radium by the Curies (1898), was followed by the applications of radium therapy to lupus (Danlos and Block, 1901) and malignant tumours (Danysz, 1903), and of ultraviolet light to tuberculosis by Rollier, to rickets by Kurt Huldschinsky (1918). Cancer, in particular, still remains very much of a surgeon's problem. Apart from the occasional successes of radium-therapy in superficial epithelioma and other local malignancies, the best results have so far been obtained with the knife. On the pathogenetic side, the first successful transplants in rodents were made by Arthur Hanau (1889). It was confirmed and followed up by Moran (1894), Leo Loeb (1901) and Jensen (1902-3), who carried sarcoma through some 40 generations of mice. During 1910-15, the initial observation of Pott on soot cancer in chimney sweeps (1775) was extended to tobacco smoking, betel nut chewing, biliary calculus, nematoda (Borrel, 1910), Kangri burns (Neve, 1910), tar (Bayon, 1912) culminating in the brilliant work of Fibiger on nematode irritation in mice. All this tended to confirm the initial observation of Virchow that the exciting cause of malignancy is local irritation. The remarkable experiments of Peyton Rous on the transference of sarcoma in Plymouth Rock chickens by transplants or inoculation with a cell-free filtrate (1911-14) were continued by Carrel and Burrows (1911), and other of the Rockefeller Institute. In 1926, Gye and Bernard announced that the Rous sarcoma virus is made of two negative components, one obtained from

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a cell-free filtrate killed with chloroform, the other from a "primary culture" kept at standstill until its potency is nil, and that these combined will produce a positive result on inoculation. The most striking and significant experimentation was that of Maude Slye (Chicago) who by selective breeding of mice showed that resistance to malignancy is a Mendelian dominant, susceptibility a recessive. Murphy regards resistance as a lymphocytosis which can be accelerated by gentle Röntgen irradiation and destroyed by strong x-ray stimulation.

Thus the possibilities of irradiation, of serum-, vaccine- and protein-therapy, of iodine in goitre and of irradiated cod-liver oil and foods in rickets, of alcohol injections in neuralgia, of artificial hyperemia and transfusion, prelude the "biological period," in which the surgeon becomes more and more of an internist, and surgery itself more conservative. The note of preventive surgery was sounded in Volkmann's treatment of tuberculosis of the bones and joints by iodine, cod-liver oil and diet.

Recent surgery owes much to improvements in anaesthesia. Following the suicide of Horace Wells (1848), nitrous oxide anaesthesia was discarded but was revived by its original discoverer G.Q. Colton (1862). Up to 1900, chloroform was the preferred anesthetic in the Western states, but the NO_2-O (gas oxygen) mixture was revived by Goldmann (1900), Halsted and Crile, forestalling shock by a preliminary injection of scopolamine and morphine

(anoci-association). Meanwhile, following the introduction of cocaine by Anrep (1879-84) and Koller (1884), Halsted developed all its possibilities in conduction anaesthesia (nerve-blocking) after hazardous experimentation upon himself (1885), while Corning (1885), Matas (1899) and Bier (1899) employed it by the spinal route. The infiltration anaesthesia of C.L. Schleich (1894-5) was already known to Halsted, who even got results with plain water. Conduction anaesthesia was put into general practice by Crile (1897-1900) and Cushing (1900). Novocaine (Einhorn, 1905) was employed by Balfour (1913) in nerve-blocking and is now the accepted anaesthetic in surgery and dentistry. The open drop method in administering ether was introduced by Prince (1893) to replace the Morton flask and Clover cone (rebreathing). Friedrich Trendelenburg (1844-1924), of Berlin, a pupil of Langenbach, is memorable for his graduating dissertation on ancient Indian surgery (1866), his introduction of gastrostomy in oesophageal stricture (1877) and for his high pelvic posture in operating on the viscera (1881). In 1908, he essayed the feat of operating for embolism of the pulmonary artery.

The acknowledged leader of recent German surgery is August Bier (1861- who introduced intraspinal anaesthesia with cocaine (1899), and active and passive hyperemia as an adjuvant in surgical therapy. Infiltration anaesthesia (1894) was introduced by Carl Ludwig Schleich (1859-1922).

Ernst Ferdinand Sauerbruch (1875-), of Barmen, Rhenish Prussia, greatly advanced the possibilities of intrathoracic surgery by his invention of the pneumatic chamber at reduced atmospheric (negative) pressure for the prevention of pneumothorax. In 1909, Samuel James Meltzer and John Auer, of the Rockefeller Institute, greatly simplified matters by the method of intratracheal insufflation of air through a tube passed into the trachea, producing "continuous respiration without respiratory movements".

Prominent German surgeons of today are Hans Kehr (1862-1916), author of authoritative treatises on gall-stone surgery (1896-1901); Emil Werner Körte (1853-), of Berlin, who has excelled in pancreatic (1898-1903) and visceral surgery; Edwin Payr (1871-); Erich Lexer (1867), of Würzburg, who worked on plastic surgery; Victor Schmieden (1874-), of Berlin; and Heinrich Ernst Albers-Schönberg (1865-1921), who was the leader of Röntgenology in Germany. Georg Perthes (1869-1927) was the originator of deep Röntgen-therapy (1903) and a prime-mover of the treatment of cancer by irradiation.

Of English surgeons who have rendered distinguished service during the European War, Sir Berkeley Moyniham (1865-1936) made valuable contributions on abdominal operations. Sir Robert Jones (1855-1933), of Rhyl, Wales, the guiding spirit of the British and American orthopaedic services during the war, was the author of a book on injuries of the joints (1915), <u>Notes on Military Orthopaedics</u> (1917) and <u>Orthopaedic Surgery</u> (with R.W. Lovett, 1923). Alfred Herbert Tubby (1862-) has written treatises on

<u>Deformities</u>. Sir William Arbuthnot Lane (1856-) was noted for his work on the treatment of fractures by plates and screws and on treatment of chronic intestinal stasis (Lane's kink) by short-circuiting the intestine (1903).

Marin-Théodore Tuffier (1857-1929) was the author of experimental studies on the surgery of the kidney, and of monographs on the surgical treatment of phthisis (1897-1909). He popularized spinal anaesthesia in France. René Leriche (1879-), who introduced periarterial sympathectomy (1917-22), has written on fractures (1916-17) and diseases of the bones (1926).

The last few years are remarkable for a revival of Hunterian or physiological surgery. Just as Marion Sims and Billroth, in their specialties, advanced the clinical pathology of visceral diseases, so we find Kocher, Horsley, von Eiselsberg, Halsted, Crile, Cushing, Carrel, Murphy, not only thinking physiologically in their work, but making many new departures by means of experimentation on animals.

By common consent, the leader of this group was Theodor Kocher (1841-1917), of Bern, Switzerland, who was a pupil of Langenbeck and Billroth. Kocher was remarkable for his method of reducing dislocations of the shoulder-joint (1870), and for his work on the thyroid gland. He was the first to excise the thyroid for goitre (1878), and performed this difficult operation over 2000 times with only $4\frac{1}{2}$ per cent. mortality.

The leading surgeon of Austria was Anton von Eiselsberg (1860-1939).

He was one of the first to notice the appearance of tetany after goitre operations.

William Stewart Halsted (1852-1922), of New York, in 1884, first performed refusion or centripetal transfusion of a patient's own blood, after defibrination, in CO-poisoning. He was a pioneer in conduction and infiltration anaesthesia by cocaine (1885), and devised the well-known supraclavicular operation for cancer of the breast (1889). He did much work in experimental surgery.

George Washington Crile (1864-), of Chile, Ohio, is the author of highly original experimental researches on surgical shock (1899), blood-pressure in surgery (1903), haemorrhage and transfusion (1909). He has worked with particular ability in minute "block dissections" of the lymphatics in cancer. His theory of "anoci-association," the blocking of shock in operations by the combination of general and local anaesthesia (morphia and scopolamine followed by nitrous oxide and novocaine), with less than 1 per cent. mortality, is an important contribution to surgery.

Harvey Cushing (1869-), of Cleveland, Ohio, professor of surgery at the Johns Hopkins (1902-11) and Harvard Universities (1912), stands <u>facile princeps</u> in neurological surgery, particularly in surgery of the head and the pituitary body. He has done original work in experimental physiology, pathology and surgery, and more than any other surgeon to demonstrate

the possibility of operative relief for intracranial conditions notably in decompression for intracranial haemorrhages in the newborn (1905) and inaccessible tumours (1905), the surgery of the pituitary body (1909-12) and of tumours of the eighth nerve (1917). Cushing described the longitudinal sinus disease (1917), and (with Percival Bailey) has made a histological classification of the cerebellar gliomata (1926), correlating the clinical signs with the kind of tumour. In his work on the pituitary body, he has thrown much light on its physiological functions. His _Life of Sir William Osler_ (1925) is one of the best and most successful of medical biographies.

Of recent American neurological surgeons, Charles Harrison Frazier (1870-), of Germantown, Pennsylvania, is the _opérateur par excellence_ in trigeminal neuralgia.

Great advances have been made in vascular surgery by the experimental method, with the aid of the aseptic absorbable ligature.

The first case of a successful venous suture was the celebrated "Eck fistula" (1877), which has since been applied by Pavloff. Schede succeeded in suturing the femoral vein, and, by 1892, had 30 successful cases. Dörfler (1890) employed a suture passing through all three arterial coats. By proceeding aseptically, he avoided thrombosis, and, in 1891, Durant applied the method with success in two cases of arterial suture in man.

John Benjamin Murphy (1857-1916), after many experimental end-to-end

resections of wounded arteries and veins, successfully united a femoral artery, severed by a gunshot wound, in 1896. He had already done epoch-making work in the production of "cholecysto-intestinal, gastro-intestinal, entero-intestinal anastomosis and approximation without sutures" by means of a special button (1892). He had remarkable results with bone-grafts.

Alexis Carrel (1873-), of Sainte-Foy-les-Lyon, France, has revolutionized the surgery of the vascular system and made great advances in physiology and physiological surgery. He has isolated tissue cells in pure cultures and developed technical methods by which these strains can be kept indefinitely in an active condition outside the body. During the World War, he did work of lasting value in the treatment of wound infection with the Dakin solution and on the rate of healing of wounds.

Internal medicine, in its recent phases, harks back to the two main trends of Greek medicine, the Coan and Cnidian: on the one hand the time-honoured Hippocratic method; on the other an almost bewildering array of laboratory tests. In diagnosis, apart from the biochemical methods and blood tests of Folin, Van Slyke, and others, most of the functional tests are prognostic. The tests for renal function include total nitrogen (Kjeldahl, 1913), residual (non-protein) nitrogen (Morris, 1911; Folin and Dennis, 1912-13; McLean, 1914-16). In diabetes and the glycosurias are the tests of Benedict for urinary sugar (1908), of Trommer (1905) and Rothera (1908) for acetone bodies. Hepatic function is estimated by such tests as the Van den Bergh (1918) for bile-pigments (urine and blood).

The George and Gladys Dick tests (1924) for diphtheria and scarlatina are notable. A recent advance in the field of blood and circulation is the thrombo-angiitis obliterans of Leo Buerger (1908).

In gastro-enterology, much is due to Röntgenography, to the Coolidge tube (1913), to W.B. Cannon who introduced bismuth meal in animals (1897-8), to Holzknecht, Haudek and Groedel, who popularized the use of the fluorescent screen and made the first effective serial plates of the stomach in man (1909-12), and to A.F. Hurst who made x-ray studies of defaecation and constipation. The discovery of the sphincter of the common bile-duct (Oddi, 1887) by Simon P. Gage (1879) and the introduction of non-surgical drainage of the gall-bladder by S.G. Meltzer (1917) and Lyon (1919) are among the brilliant achievements of recent Americans. In 1905, W.J. Mayo showed that duodenal ulcer is ten times more frequent than gastric ulcer. Duodenal intubation with the small tube is associated with the name of Einhorn. The principal dietetic schemes for gastric ulcer are those of Leube (1897), Lenhartz (1904), Lambert (1908) and Sippy (1915).

Tests of gastric function include the test-meals of Ewald (1890) and Rehfuss (1914), x-ray examination (Cannon, 1898), and detection of blood in the faeces.

In neurology, many new tests for neurosyphilis by examination of the cerebrospinal fluid have been introduced, notably the butyric acid test (Noguchi, 1909), and the colloidal gold reaction (Lange, 1912). The

simplified complement-fixation test of R. L. Kahn (1924) supplements the Wassermann reaction (1906).

Two main currents of recent therapeutics are purposeful dietetics (nutritional therapy) and protein therapy.

Dietetics, one of the basic principles of Hippocratic therapy, has, therefore, come into its own again. In the artificial life of city people, the adjustments of the body to food are as delicate and dubious as those in the newborn infant. The conclusions of McCarrison, McCollum, and others are that an ideal normal diet would consist of whole wheat, milk, and milk products, uncooked vegetables, sprouted legumes, fresh meats and fruit, with specific avoidance of white bread, tea, sugar, boiled vegetables, margarine, tinned meats and jams.

Salient among the recent triumphs of nutritional therapy is the prevention and arrest of goitre by overcoming iodine deficiency.

The discovery of thyroxin in the thyroid gland by E.C. Kendall (1914), reduced the incidence of goitre by exhibition of small doses of sodium iodide (1917-20). The use of butter-fat against xerophthalmia, keratomalacia, and night-blindness (Osborne and Mendel, 1913), of unhusked rice against adult beriberi (1897) and of tiqui extract against infantile beriberi (1912), of cod-liver oil (E. Mellanby, 1919) and foods irradiated with ultraviolet light (Steenbock and Black, 1924) against rickets, are

among the advances in vitamin therapy. In 1925, G.H. Whipple and F.S. Robscheit-Robbins showed the beneficial effect of raw beef liver upon blood regeneration in anemia, which was then applied to the treatment of pernicious anemia in practice by G.R. Minot and W.P. Murphy (1926).

The rationale of protein therapy is, roughly speaking, "a hair of the dog that bit you," or one disease cures another; but its scientific locus standi is Weigert's law, viz., that a local injury or necrosis will usually start reparative processes in excess of requirements (1871-3). The theory of the subject grew up around the treatment of bacterial infections with specific therapeutic effect in other diseases.

In 1905, Winter showed that a stopped heart can be resuscitated by adrenalin injections. The beneficial effect of malarial infection in epilepsy was known to Hippocrates and no less than 164 cases of its curative effects in paresis and insanity were recorded by earlier writers. In 1887, Julius Wagner von Jauregg (1857-), of Vienna, postulated the general theory of the influence of febrile diseases upon psychoses and after some twenty years of observation of the beneficial effect of such diseases upon paresis, began to inoculate paretic soldiers with malaria in 1917. Meanwhile, Felix Plaut got similar results with relapsing fever (1919). Kunde, Hall, and Gerty have treated paresis by foreign proteins without the use of the living plasmodia (1926). The general consensus of opinion is that protein therapy is more commonly successful, not in

general but in local infections, such as the arthritides, gonorrhea, asthma, neurosyphilis, cutaneous and ocular diseases. The reactions are different in different animals, and as toxic doses are fatal, and the threshold dose varies in different individuals, the method is fraught with danger, e.g., in the use of krysolgan and sanocrysin in phthisis. Protein therapy and stimulotherapy appear to obey the Arndt-Schulz law (1885-7), viz., that weak stimuli accelerate vital activities, strong stimuli inhibit them, maximal stimuli abolish or destroy them.

The journals swarm with new remedies of specific or synthetic type, the most remarkable, if not reliable, being insulin (Banting and Best, 1922); ephedrine (Nagai, 1887); krysolgan (A. Feldt, 1917), sanocrysin (Holger Møllgaard, 1924), plasmochin (Elberfeld group, 1925), ergosterin (György, et al., 1927) or the general use of iodine as antiseptic (Pregl's solution, 1921).

Obstetrics has only just entered the preventive phase, but antenatal care (puericulture) is now a matter of world-wide interest. Much was due, in the first instance, to the writings of John William Ballantyne (1861-1923) on Diseases of the Foetus (1892-5), Antenatal Pathology and Hygiene (1902-4), and latterly to the reports of E.L. Holland (1922) and Janet Campbell (1924) on maternal and foetal mortality. Among the most striking manifestoes are the coloured posters of the Department of Maternal and Infant Welfare of the Central Soviet Government.

The recognition of autogenous puerperal sepsis and its prevention by aseptic and mild antiseptic measures is of recent date. By far the most striking advance in preventive obstetrics is the expectant treatment of eclampsia by means of quietude, isolation in a dark room, and exhibition of sedatives and purgatives, which was introduced by Vassili Vassilievich Stroganoff (1857-) in 1897, with such recent modifications as the additional use of magnesium sulphate (E.M. Lazard, 1897).

In gynaecology the most notable advance has been the establishment of the true nature of ovarian endometriomata (chocolate cysts) by J.A. Sampson (1922). On the therapeutics side, the most telling advance is the diagnosis and treatment of sterility from occlusion of the Fallopian tubes by insufflation of the tubes with gas, devised by I.C. Rubin (1920) of New York.

Allvar Gullstrand (1862-), of Landskrona, Sweden, professor of ophthalmology in the University of Upsala (1894) made mathematical investigations of dioptrics or the science of the refraction of light through the transparent media of the living eye.

Two prominent innovations in eye surgery of recent times have been made by officers of the Indian Medical Sèrvice. The operation of extraction of cataract within the capsule was introduced by Lieutenant-Colonel Henry Smith in 1900. As a benefactor of humankind, he is known all over northern India, where the reflection of the pitiless sunlight from the dusty plains tells with terrific force upon the eyes of the natives. Another new oper-

ation, that of sclerocorneal trephining for glaucoma, was introduced by Major Robert Henry Elliot, I.M.S., in August, 1909.

In the field of otology Robert Bárány (1876-), of Vienna, has done much to clear up the hazy subject of aural vertigo, or Ménière's disease.

Recent advances in oto-rhino-laryngology have been mainly along lines of improved instrumentation, such as the use of the electric audiometer in testing for deafness, indeed, the use of mechanical and biochemical aids as surrogates for the evidence gained by the senses has extended to nearly all branches of practical medicine.

The rise of modern epidemiology is associated with William Farr's article on vital statistics (1837).

The modern English school stems from Charles Creighton (1847-1927). His <u>History of Epidemics in Britain</u> (1891-94) is now admitted to be a classic of unimpeachable accuracy, but his unfortunate brief against vaccination (1889), with his subsequent attack on Jenner (1889), rendered him anathema in British opinion, isolated him as a recusant, and delivered him into the hands of the anti-vaccinationists.

Of the newer men who have come under Creighton's influence, Major Greenwood (1880-), professor of epidemiology in the University of London (1926), has made valuable studies of Sydenham (1919) and Galen (1921) as epidemiologists. Sir Ronald Ross (1857-) has obtained epi-

demic curves corresponding with the normal bell-shaped Farr-Pearson curve. Raymond Pearl has analyzed the effects of density of population in lowering the birth-rate. The ablest historian of epidemiology in recent times is Georg Sticker (1860-), of Cologne, who has dealt with the space-time phases in his exhaustive clinical monographs on whooping cough (1896), hay-fever (1896), plague (1908-10), influenza (1911), cholera (1912), dengue (1914), colds (1915), leprosy (1924), tropical fevers (1925), and his scholarly surveys of the general history of epidemic diseases.

Of the brilliant group of Italian clinicians and epidemiologists, Angelo Dubini first described the European hook-worm disease (1843); and Guido Baccelli (1832-1916), of Rome, evoked the incomparable Renaissance glory of Italy in medicine and became widely known by his account of aphonic pectoriloquy in pleural effusion (Baccelli's sign, 1875), by his methods of treating aortic aneurysm by the introduction of a coil of metal in the walls (1876) and the injection treatment of malaria with quinine (1890), syphilis with corrosive sublimate (1894), and tetanus with carbolic acid (1905). At Naples, Arnaldo Cantani (1837-93) founded the first bacteriological laboratory in Italy (1885); and Antonio Cardarelli (1821-1916) was memorable for his tracheal sign in aortic aneurysm. At Catania, Salvatore Tommaselli (1830-1902) studied quinine intoxication in malaria (Tom-

maselli's syndrome). Camillo Golgi (1843-1926), Ettore Marchiafava (1847-1916), Angelo Celli (1858-1914), Battista Grassi (1855-1925), Amico Bignami and Vittorio Ascoli, all made their mark by effective work on malarial fever. Pietro Grocco (1856-1916), of Pavia, described paravertebral dulness on the opposite side in pleural effusion (Grocco's triangle, 1902). Guido Banti (1852-1925) described splenomegalic anemia (1898). Adelchi Negri (1876-1912) discovered the Negri bodies in hydrophobia (1903-4). Aldo Castellani, a medical graduate of Florence, found Dutton's Trypanosoma gambiense in the cerebrospinal fluid of sleeping sickness patients (1903), and the spirochaete of yaws (1905), was a pioneer in investigating the bronchomycoses which simulate phthisis.

Here may be signalized two recent phases of 20th century medicine, namely, the rise of medicine in Latin America and Japan.

Although up to recent years, the Latin-American countries have been intellectually provinces of Spain, with some impetus from French and German influences here and there, the medicine of Latin America bids fair to surpass that of Spain. In Cuba, Carlos Juan Finlay (1833-1915) first stated the theory of mosquito-borne yellow fever (1881), and excellent work has since been done by Juan Guiteras (1853-1925), Aristides Agramonte (yellow fever) and Juan Santos Fernandez (1847-1922) (ophthalmology). Brazil numbers such remarkable physicians as Gaspar Vianna, who introduced antimony

tartrate injections in kala-azar, and Chagas. Parasitology received a great impetus at the hands of Oswaldo Gonçalvez Cruz (1872-1917), who became director of public health at Rio in 1903. In 1901, he founded the Institute at Maguinhos to which the citizens of Rio gave his name in 1908. Here Carlos Chagas discovered the Trypanosoma Cruzi and described the infective thyroiditis produced by it (1909). From this Institute have emanated innumerable investigations of the novel insects, parasties and venomous reptiles with which Brazil abounds. The Instituto Butantan (Sao Paulo), founded by Vital Brazil (1899), was one of the earliest distributing stations for large-scale production of sera against snake-poisoning and was an incentive to the foundation of an antivenin Institute at San Antonio (Texas).

In modern Japan medical education and investigation have thriven largely under German influence. Anatomy was established in Japan by Kazuyoshi Taguchi, physiology by Kenji Ozawa, biochemistry by Muneo Kumagawa (1839-1902) and Torasaburo Araki, pathology by Moriharu Miura, bacteriology by Shibasaburo Kitasato and Masaki Ogata. Kitasato is the founder of the Governmental (1892) and the Kitasato Institutes (1914) for Infectious Diseases in Tokyo.

The bacillus of dysentery was discovered by Kiyoshi Shiga (1897). In parasitology, introduced by Isao Ijima, Japan has already achieved a most brilliant record, particularly in the science of the trematode worms. In

1904, Fujiro Katsurada and Akira Fujinami discovered Schistosomum Japonicum and described schistosomiasis, the intermediate host having been discovered by Keinosuke Mujairi and Minoru Suzuki. Metagonimus Yokogawai and its second intermediate host were, both of them, discovered by Sadamu Yokogawa in 1913. Ryukichi Inada and Yutaka Ido discovered the spirochaete of infectious jaundice (Weil's disease) and developed a successful serum-therapy for the infection in 1914-15. The parasite of rat-bite fever (Spirochaeta muris) was discovered by Kenzo Futaki and Kikutaro Ishiwara. The second intermediate host of Clonorchis sinensis was discovered by Harujiro Kobayashi (1911-14); the intermediate host of Paragonimus Westermanii (Ringer, 1879) by Koan Nakagawa (1914-15). The migratory course of human ascaris was demonstrated by Sadao Yoshida, and in 1920, Hideyo Noguchi discovered the parasite of yellow fever (Leptospira icteroides) at Guayaquil and died a martyr to the disease in Africa (1928).

The last ten or twenty years have witnessed an unusual growth of interest in the history of medicine. Max Neuburger (1868-), author of valuable histories, began to teach the subject forty years ago (1898) and succeeded to Puschmann's chair (1904).

The subject is now taught by Theodor Meyer-Steineg (1873-), Paul Diepgen, Wilhelm Haberling, Georg Sticker, the historian of epidemiology, Henry E. Sigerist (1891-), and Charles Singer.

In the United States, chairs have been held by Cordell (Baltimore), Packard (Philadelphia) and others. The pioneer in post-graduate teaching

was William Snow Miller (1858-   ). In 1926, William H. Welch was appointed professor of history of medicine in the Johns Hopkins University, with a prospective Institute and Library, which will undoubtedly become a centre for post-graduate instruction in methods of research and a seed-plant of medical culture.

The most important advance of recent years was the foundation of the Institut für Geschichte der Medizin at Leipzig, in 1905, under the direction of Karl Sudhoff. Karl Sudhoff (1853-   ), of Frankfort on the Main, began his studies with his important investigations of Paracelsus. He has written exhaustive and scholarly monographs on the iatromathematicians of the 15th and 16th centuries, the early history of anatomical illustration (1908), and German medical incunabula. He has shown, by collation of unprinted manuscripts, that up to Vesalius, the textual illustration of anatomy was for centuries based upon servile tradition and almost devoid of any signs of original observation. Sudhoff has also developed the whole science of the Lasstafelkunst, and during this research, he discovered the first medical publication to be set in type, Gutenberg's purgation calendar of 1457, in the Bibliothèque nationale in Paris. His original investigations and reproductions of the mediaeval writings on leprosy, plague and syphilis, including the preventive ordinances, go far beyond the labours of Haeser in this field.

CULTURAL AND SOCIAL ASPECTS
OF MODERN MEDICINE

During the 19th century we see the effects of the modern spirit of industrialism upon ethical relations. The physician became more and more impersonal, more of a business man, and not so much influenced by the social and ethical obligations which were certainly a characteristic of the 18th century physician. The "family doctor" of the past has well-nigh disappeared. The modern type everywhere is one of clean-cut business efficiency. Modern science has done away with the idea of personal infallibility, has centred itself upon results and has a fine probity of its own. The most enlightened physicians of today are advancing preventive medicine, which tends to do away with a great deal of medical practice. The socialization of medicine by panel practice has imposed much extra work at small compensation upon English physicians.

Modern art, like that of the 17th century, has represented medical subjects in varied and manifold ways. One prominent characteristic of modernity, "the strange disease of modern life", is to seek what is odd and new, and, in art, to find inspiration in ugliness. Goya's canvasses in the Prado, for

instance, and particularly his etchings, are triumphs of the <u>macabre</u>. Others show the tendency toward realistic or photographic representation. Many modern medical men have illustrated their own works, in particular the Bells, Bright, Hodgkin, Henle, His, Leidy, and Lister. Sir Seymour Haden, the surgeon, was one of the most accomplished of modern etchers.

German university teaching was for a long time didactic, but with the foundation of such laboratories as Purkinje's at Breslau (1824), Liebig's at Giessen (1825), or Virchow's at Berlin (1856), there was a new departure.

England and France excelled mainly in the organization of hospital and clinical teaching. German medical education is based upon the sound assumption that all the specialties, even dentistry or obstetrics, are so many phases of physics and chemistry. In the United States, conditions were entirely different. In colonial times, the medical student, however poorly educated, had, at least, the advantage of being under a preceptor, and thus coming into actual contact with some details of medical practice. In the first half of the century, ambitious and enterprising American students, who had the means, were going to Paris to study under Louis, or to Astley Cooper in London; in the later period, they were swarming to Virchow in Berlin, to Charcot in Paris, or to Billroth in Vienna. It was only toward the end of the 19th century, under the direction of Eliot at Harvard, Billings, Welch, and Osler at the Johns Hopkins, and Pepper in Philadelphia, that medical teaching began to be true university teaching.

On the continent, clinical medicine was ably taught by Corvisart, Laennec, Louis and Trousseau in Paris, Schönlein and Frerichs in Berlin, Skoda and Oppolzer in Vienna. Corvisart was the reviver of percussion. The stethoscope, in Laennec's hands, was the means of developing the science of diseases of the chest. Louis and the Irish clinicians introduced pulse timing by the watch. Piorry invented the plemimeter. Wunderlich put clinical thermometry upon a scientific basis. Thermometers began to make their appearance in English hospitals about 1866-67, and came into general use about 1868-70. They were about 10 inches long. Their reduction in size, indeed the invention of the pocket thermometer, was due to Sir Clifford Allbutt (1868).

In 1840, Schönlein introduced the novelty of lecturing in German at the Charité. Schönlein's clinics were of the highest scientific order. After him came Frerichs (1859), who kept up the same traditions. Therapy was carefully considered by Frerichs. Traube, who became clinical director of the other wing of the Charité in 1853, was also esteemed for his exact diagnoses. He was more conscientious and sincere in bedside examination, more interested in his patients than Frerichs. Meanwhile Virchow was the bright particular star of the Berlin School, a political revolutionary in his youth, an intellectual tyrant in old age. At Vienna, Skoda was all for auscultation Rokitansky all for postmortems, and Oppolzer was the best all-round teacher. Of the later Berlin group, it was said: "Gerhardt makes a diagnosis usually,

Senator often, Leyden never" (Jacobi). In England, Addison was easily the greatest clinical lecturer of his time, feared by his students on account of his cold, arbitrary manners and his martial outside. The genial, even-tempered Bright ran him an easy second. With Bright, Addison, and Hodgkin, pathology and clinical medicine went hand in hand. After them came Gull, Wilks, and Fagge, all effective teachers. In France, Trousseau was the most vivid and picturesque lecturer of the period. Charcot's public clinics were unique of their kind, he deliberately dramatized and visualized the essential features of a case. When the patient was dismissed, the pathological lesion would immediately be thrown upon a screen at the back of the stage.

In the earlier American schools, clinical teaching was largely didactic. This defficiency was set off, in the later period, by the post-graduate school, in which the teaching was entirely practical, and which Flexner has satirically dubbed "an undergraduate repair shop." Nearly every university, medical school, hospital, or health department in the country has now a pathological laboratory. In 1859, the Chicago Medical College introduced the novelty of a three years' graded course of study, but the requirements were not rigidly adhered to. Billing's original recommendations for the Johns Hopkins Hospital (1875) included: Not only the care of the sick poor, but the graded accommodation of pay and private patients in rooms or suites of rooms, proper education of physicians and nurses, and, above all, the promotion of "discoverie in the science and art of medicine, and to make these known for the general

good". With Osler as physician-in-chief, Welch, Halsted, and Kelly in the chairs of pathology, surgery, and gynaecology, a brilliant and efficient medical faculty was soon developed. In the teaching and practice of surgery, the Mayo Clinic, at Rochester, Minnesota, has become a Mecca for post-graduate instruction.

In 1909-11, Abraham Flexner, at the instance of the Carnegie Foundation for the Advancement of Teaching, made two close comprehensive studies of the status of medical education at home and abroad, and his strictures on American conditions excited a storm of comment and criticism.

During the World War and after, there has been a great dearth of physicians in all civil and rural communities. In pre-war Russia the deficiency was supplied by the institution of "civil Feldscherism". The civil Feldscher has been defined as the "leib-medik of the moujik", in other words, a half-fledged, half-educated medical assistant.

The Anglo-Saxon has the supreme virtue of "saving common sense", but is deficient in imaginative sympathy. The French, in the view of Stuart Mill, tend to "thought without knowledge". Germanic erudition tends to "knowledge without thought", values substance more than form, and is easily gulled by pedantry, hollow bombast, dull or blatant pomposity. The composite American, while simple, plain, sensible and practical at his best, is prone to hasty generalization, snap judgments, the posting of Arcadian ideals, "the passion for the beneficient edict", whence an illimitable capacity for self-deception

with regard to values settled ages ago. German professors and students alike migrate from town to town, as in the Middle Ages. The German nurses, as in France, are of poor quality. The professor, a high priest of his science and its teaching, his brain stored with classified knowledge, is liable to acquire a heaviness of mind which may degenerate into top-heaviness. His autocratic position may sometimes be manifested as a "stiff Vornehmheit," an unpleasantly impersonal manner toward pupil or patients. In France and England the relations between teacher and pupil, professor and patient, are less official and formal. In the English hospitals the nursing system is the finest in the world.

In anatomy, the vogue for didactic or expository lecture was started by the 18th century men, the so-called "surgeon-anatomists," and particularly by the Monros at Edinburgh. Even after Bichat, Bell and Knox, and the Warburton act of 1832, anatomy was still treated as the handmaid of surgery (or of the fine arts) until the modern Germans - Henle, Gegenbaur, Waldeyer - correlated it with histology, morphology, and embryology. France has had no physiologists of the first rank since Claude Bernard, unless we regard Pasteur as an example. In England, Foster at Cambridge and Burdon Sanderson at Oxford, both pupils of Sharpey, set the pace in physiological teaching. German physiological teaching, the highest development of the century, grew out of the great laboratories of Johannes Müller at Berlin, Ludwig at Leipzig, and Voit at Munich. In pathology, all Europe sat at the feet of Virchow and his pupils,

of whom Cohnheim was the teacher of Welch, who with Prudden, brought experimental pathology and bacteriology to America. The French indifference to pathology is shown by the fact that two neurologists, Charcot and Marie, held the chair for years, the former succeeding Vulpian in 1872. Bacteriology has been best taught in France at the Pasteur Institute and its branches; in Germany, at the institutes of Koch, Ehrlich, von Behring and others; in Belgium, by Bordet; in America, by Welch, Simon Flexner, Vaughan, Novy, Abbott, Ernst and others. "Bacteriology," says Flexner, "transformed hygiene from an empirical art into an experimental science". Experimental pharmacology was first taught by Magendie in France and by Buchheim, Traube, and Schmiedeberg in Germany. Brunton, Ringer, Langley and Cushny in London, Fraser in Edinburgh, represent the height of English teaching. H.C. Wood founded clinical pharmacology in America. Cushny at Ann Arbor, and Abel at the Johns Hopkins introduced the modern German methods. By 1832-33 every medical school in Great Britain had lectures on forensic medicine. Legal medicine is now best taught at Vienna, where all judicial autopsies, coroner's cases, and anything medical connected with court-room procedure, are under control of the university professor.

Schools of tropical medicine were established at London (1899), Liverpool (1899), Hamburg (1900), and Brussels (1906).

America, beginning with Elizabeth Blackwell's graduation in 1849, was the pioneer in medical education for women.

The Woman's Medical College of Pennsylvania (Philadelphia) was organized in 1850, and the Woman's Medical College of Baltimore in 1882. In 1874, the

London School of Medicine for Women was opened with fourteen students; and in 1896, they acquired the privilege of resident posts at the Royal Free Hospital. In the same year, the Royal College of Physicians in Ireland and the London University admitted them to the privilege of examination.

Of the many admirable hospitals constructed in the modern period, the pavilion system attained a high plane of development in the Johns Hopkins Hospital.

Some 37 institutions for the blind were established in Great Britain between 1791 and 1897. The Berners Street workshop, started by Miss Gilbert, the blind daughter of the Bishop of Chichester, set a model which has been widely copied. Schools for the deaf were established at Edinburgh (1810), Glasgow (1819), and elsewhere.

The introduction of outdoor life and open-air sanitaria for phthisical patients is a feature of modern medicine. Open-air treatment existed in Scotland about 1747 and a seaside hospital for scrofula was opened at Margate in 1791. George Bodington (1799-1882), of Sutton Colfield, England, in his <u>Essay on the Treatment of Pulmonary Consumption</u> (1840), anticipated many modern views as to the advantages of cold dry air for "healing and closing of cavities and ulcers of the lungs". The first sanitarium for phthisical patients was established at Görbersdorf, in the Waldenburg Mountains, by Hermann Brehmer (1826-99), in 1859. It still exists, and its success has led to the foundation of many similar institutions in mountain and winter resorts, notably those of Carl Spengler at Davos and Edward Livingstone Trudeau (1848-

1915) at Saranac Lake in the Adirondacks. In 1876, Peter Dettweiler (1837-1904) founded the sanitarium at Falkenstein in the Taunus.

The nursing of the sick at the hands of the trained, well-bred women is an institution of modern times. The idea of training nurses to attend the sick in a special school for the purpose originated with Theodor Fliedner (1800-64), pastor at Kaiserswerth on the Rhine, and his wife Friederike. To the Fliedners came, in 1840, Elizabeth Fry, famous for her extension of John Howard's work in sanitating prisons, and later Forence Nightingale (1823-1910), who devoted her whole life to sick nursing and, indeed, made it the model institution which it is in English-speaking countries today. The effect of her unexampled success was such that after her return to England from the Crimea a sum of £50,000 - the Nightingale Fund - was raised to establish a school for nurses at St. Thomas' Hospital. In America, the movement was especially furthered by Elizabeth Blackwell and Marie Zakrzewska, who founded the first training-school for nurses in the United States (1873).

Miss Nightingale's <u>Notes on Hospitals</u> (1859) and <u>Notes on Nursing</u> (1860) are true medical classics, distinguished by the rarest common sense and simplicity of statement.

Since the time of Pinel and Reil, Tuke and Conolly, the proper study and care of the insane has been an object of ambition. Gardner Hill introduced the idea of "no restraint" at Lincoln Asylum, England (1836) and, in 1839, in the face of bitter opposition, John Conolly discarded all mechanical restraints

at the Hanwell Asylum. In 1885, Daniel Hack Tuke made a sweeping attack on American and Canadian asylums, and in 1894, Weir Mitchell pointed out the deficiencies in the proper care and treatment of the insane, and indicated the absolute lack of any scientific study of insanity in American hospitals. The latter idea originated with the Germans. The very first article which Griesinger penned for his Archiv (1868) proposed a reorganization of the German hospitals and outlined the idea of a psychiatric clinic, the movement culminating in the fine institution opened by Kraepelin at Munich, November 7, 1904. On April 16, 1913, the Psychiatric Clinic, donated to the Johns Hopkins University by Henry Phipps, and modeled along the German lines, was opened. Kraepelin's new Institute was opened on June 13, 1928.

The first attempt at the training of idiots was made by the celebrated otologist J.-M. G. Itard in 1800 upon a wild boy found in a forest in central France. Success was at length attained by Edouard Séguin.

In the development of national and international regulation of public hygiene, necessity has been the mother of invention. It was simply forced upon the attention of legislators by the modern outbreaks of epidemic disease and by the evils resulting from poverty, shiftlessness, overcrowding, industrial conditions and migration of people from place to place. The first big scare came from the invasion of Asiatic cholera (1826-37), which skirted North-eastern Germany in 1831, reaching England in June of the same year. Heinrich Heine has left a graphic and memorable account of its outbreak in Paris.

With signal intelligence, Heine puts his finger upon the chief obstacle which public health movements have ever encountered, viz., the dread of disturbing private business.

Cholera was again pandemic in 1840-50, 1852-60, 1863-73, and at later intervals in Europe. Influenza was epidemic at intervals during 1800-81 and pandemic in 1830-33, 1836-37, 1847-48, 1889-90 and 1918-19. The epidemic of 1918-19 was probably transmitted from China (March, 1918) by Indo-Chinese troops landing in France (Zinsser) and was notable for rheumatic or dengue-like manifestations followed by fatal pneumonias and empyemas. The recent view of influenza as a disease of protean modalities is largely the work of the English school of epidemiologists. Cerebrospinal fever appeared periodically at the intervals 1805-30, 1837-50, 1854-74 and 1875. Typhus fever was rife during the Napoleonic wars and smote Ireland severely in 1817, 1819, and 1846. Bubonic plague was spread from Hong Kong all over the world from 1894 on.

In 1762, a sanitary council had been established in every Prussian province, but it was not until the second pandemic of cholera (1840-50) that France and England began to wake up to the task of organizing public health. A huge manufacturing class arose, with an industrial proletariat as its vassals, resulting in overcrowding, poverty and bad sanitation. So potent was Chadwick's propagandism for public health that it became a watch-word in the speeches of Beaconsfield. Philanthropy was the motor power in initiating sanitary reform, but the driving power came from the great expense of sanitary

Poor-Law administration and actual fear of the ever-recurring epidemics of communicable diseases.

Early English legislation, such as the Peel Act of 1802, to preserve the "health and morals" of cotton-spinners and factory hands, was directed mainly toward the hygiene of occupations, particularly child labour. The Factory Act of 1833 restricted hours of labour in children and introduced professional inspectors of factories; the Poor-Law Amendment Act, of 1834, placed local relief of poverty under centralized government control. In 1848, Parliament passed the Public Health Act. This was followed by a long line of progressive legislation, the Common Lodging Houses Acts (1851, 1853), the Nuisances Removal Act (1855), the Public Health Act of 1875, the Infectious Diseases (Notification) Acts of 1889 and 1899, the Provision of Meals Act for school children's lunches (1902), the Housing and Town-Planning Act (1909), the National Insurance Act (1911), and the Notification of Births (Extension) Act (1915). Medical inspection and treatment of school children were delegated to the Board of Education in 1907. On July 1, 1919, the Local Government Board was abolished and sanitary administration was centralized in the Ministry of Health, with Sir Christopher Addison (1869-   ) as the first minister. The first clinic for occupational diseases was opened at Milan on March 20, 1910.

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nurseries for the infants of working mothers, and through the influence of Théophile Roussel (1816-1903). The remarkable methods instituted at Villiers-le-Duc by Morel de Villiers (1854-63) were taken up by Benjamin Broadbent, of Huddersfield, England. Infant mortality work was then taken up by English public health officials, Sir Arthur Newsholme making four epochal reports to the Local Government Board (1910-16). Dr. Janet Lane-Claypon has done splendid and efficient work for this cause in England.

The development of extra-mural cemeteries was due to the propagandism of Sir Edward Chadwick, whose reports (1843-55) led to the Burial Act (1855). England has now a very efficient corps of medical officers of health, a body which is almost extinct in France. Every German university has now a hygienic institute. In Russia, public sanitation was virtually non-existent until the advent of Ivan Ivanovich Molleson (1842-1920), who was unquestionably the originator of public health officers in Russia. The metropolitan Board of Health of New York City was authorized only after considerable legislative opposition (1866). In 1901, only ten states had a satisfactory system of vital statistics (Kober). The American Public Health Association was organized in 1872. Quarantine regulations against yellow fever were established in Philadelphia in 1856. The U.S. Public Health Service has a good Hygienic Laboratory and its experts have done much admirable work, particularly in the establishment of the disease tularemia. It was independently observed in

Japan by H. Ohara (1925), who inoculated his own wife. In England, where sewage is commonly discharged into the sea, filtration beds were first employed at Wimbledon in 1876. Prior to 1847, the sewers of London were merely drains for storm-water, and the discharge of sewage into them was not permitted before that time. The labours of Edward Frankland (1825-99) and the experts of the Rivers Pollution Commission established the principle of sewage purification by means of intermittent filtration through different soils (1868-74). The improvements in sewage disposal activated by Pettenkofer in Munich and Virchow in Berlin, or the bacterial system of purification, introduced in England by William J. Dibdin (1896), have had great effect upon the mortality of typhoid fever and other water-borne diseases, as also the purification of the water-supply by sand filtration. That water is a vehicle of infection was not recognized until well after the London cholera epidemic of 1854, in which John Snow traced the infection to a pump in Broad Street. In the cholera epidemic of 1866, it was shown that the infection came from unfiltered water, furnished by one of the Metropolitan Water Companies. The writings of William Budd (1871-73) fortified the theory of water-borne cholera and typhoid by establishing the fact that infection comes from the dejecta of the patients. Sedgwick established the important principle that "quiet water, not running water, purifies itself". Prussia has probably the best system of preventing the adulteration of food and drugs.

According to Flexner, "the homeopath is the only sectarian found at all in Great Britain or on the Continent". In America, under existing conditions, every species of medical sect - osteopathy, chiropraxis, Christian Science, eclecticism, botanic medicine, etc. - has been permitted to flourish. In respect of fiduciary allegiance to Hahnemann's original doctrines, the modern homeopath is often like a skeptical or backsliding clergyman. Under the law of 1815 (55 George III, cap.194), an English apothecary was still entitled to diagnose and prescribe, and the Society of Apothecaries was authorized to license him for registration in the Medical Register. On June 21, 1869, Germany made the serious mistake of passing a statute abolishing the obligations of physicians to attend urgent calls and to treat the poor _gratis_, which incidentally let down the bars to all unlicensed practitioners who might profess merely to treat disease. The effect of this "_Kurierfreiheit_," a reflex of the democratic idealism of Virchow, was a tremendous outpouring of nature-healers, faith-healers, Baunscheidtists, exorcists, _Nacktkultur_, blue and green electricity, and occultism of all kinds.

America has been a paradise for quacks, from the time of Perkins down to the electronic reactions of Abrams and the cults pilloried by Morris Fishbein.

The British Medical Association was organized on July 19, 1832, in the board room of the Worcester Infirmary, at the instance of the late Sir Charles Hastings. The _British Medical Journal_ was founded in 1857.

In 1847, the American Medical Association was organized. Under the earlier dispensation, the aims of the Association were restricted mainly to the narrower problems of medical ethics; its present purpose is largely the direction of public opinion in regard to public hygiene and medical education. Through its Council on Health and Public Instruction, the Association has now public speakers in practically every state of the Union, who instruct the people directly in regard to infectious diseases. The _Journal of the American Medical Association_ was founded in 1883.

The highest function of the medical journalist today is to introduce new currents of scientific ideas and to keep them in circulation.

One of the striking features of modern medicine was the tendency toward internationalism, even on the field of battle. In 1862, Henri Dunant (1828-1910), a Swiss philanthropist, published his "Souvenir de Solferino", and this account of the barbarities of warfare led to the International Conference of the Red Cross Societies at Geneva in 1863, and to the signing, on August 22, 1864, of the Geneva Convention. Another sign of the international spirit is the award of the Nobel prizes.

MEDICINE IN THE WORLD WAR AND AFTER

During the war of 1914-18, the medical establishment of the British Army was administered by General Sir Alfred Keogh and later General Sir John Goodwin, that of the French Army by P.-E.-J. Simonin (1864-1920), Tuffier and Justin Godart. The Surgeon-General of the German Army during the war

period was Lieut.-Gen. Otto von Schjerning (1853-1921).

For medicine, the greatest triumph of the war was in the direct application of the science of infectious diseases to military sanitation, the group sanitation, in fact, of armies of millions. The greatest medical achievement in the World War was the conquest of wound infection. There was at length evolved the physico-chemical principle of wound irrigation by a solution of a gas in a liquid (Carrel-Dakin). H. D. Dakin's device of setting free chlorine gas from sodium hypochlorite or dichloramine-T constitutes the most refined antisepsis. The excision of all devitalized wound tissues prior to suture is an aseptic principle of the first order, of capital importance in industrial or future war surgery.

The mental tests of Binet and others were introduced into our recruiting system for the first time by Robert M. Yerkes (1917). Psychology and neuropsychiatry did much for mobilization by weeding out mental defectives, always bad risks for armies. The motley complex of neurotic phenomena going under the name of "shell-shock" was carefully studied by F.W. Mott, T.W. Salmon and others. Great impetus was given to the study of wound shock by the investigations of W.T. Porter, Cannon, Crile and Turck (cytost).

The epidemic of Spanish influenza (1918-19), with its complicating pneumonias and empyemas, was more fatal everywhere than the war itself.

That trench fever (P. U. O.) is a louse-borne infection was realized by the British Commission under Gen. Sir David Bruce and finally demonstrated by the American Commission under R.P. Strong. The relation of pediculosis

to typhus (noted by Tobias Cober in 1606) became of moment on the Eastern front, particularly in Servia, where many American physicians succumbed to the disease. Spirochaetal jaundice (Weil's disease) was investigated by R. Inada and Y. Ito (1914-15), Adrian Stokes and others; effort syndrome (D.A.H.) by Thomas Lewis. Trench-foot (Gamaschenkrankheit) was resolved by Osler into the equation: Cold bite + muscle inertia = trench foot. Under the leadership of General Sir Robert Jones orthopaedic surgery was materially advanced in England. Remarkable was the work of Alexis Carrel at Compiegne on wound treatment, of Crile, and of H.D. Gillies. Notable contributions to the pathology of war-gas poisoning were the studies of Sir Leonard Hill (1915-20), E.B. Krumbhaar (1918-19), A.S. Warthin (1919), M.V. Winternitz (1920), F.P. Underhill (1920) and H.L. Gilchrist (1922).

Through infant welfare activities, in the very midst of the war, the infant death-rate was, in 1916, brought down to 91 per 1000 in England, and 97 in Scotland, in both cases the lowest on record. In France, due to the increased employment of women in munition factories, there was a steady rise in infant mortality after 1915, reaching 126 in 1917.

The effects of the World War upon the civilian population of Europe were serious and lasted over a full decade in such forms as high nervous tension, great increase in heart disease, and neurotic conditions. In Germany, Friedrich Müller tells us, gout disappeared entirely with deficiency of meat, but the indigestible war-bread, compounded of bran, turnips, potatoes and whole wheat, along with the subsequent reduction in diet to 1100-96 (officially 1350)

calories, produced not only loss of weight, but muscular atrophy, loss of strength, and eventually hunger edema. Infantile rickets increased eight-fold, and a new kind of babies (Kriegsneugeborne) came into being, underdeveloped at birth, with symptoms of constant restlessness and automatic grasping movements. The German collapse in 1918 was, in part, due to starvation in the zone of the interior. In Vienna, Constantinople, and the larger cities, the enriched profiteers fed well while the poor starved. The gentle, the refined, the learned were driven into menial employments and prostitution. That the abnormal restlessness of recent people, at work or at play, is a neurotic phenomenon, engendered in part by wartime or post-bellum excitement, is self-evident, for similar manifestations were observable in the French Revolution or after the Napoleonic Wars.

During the war period (1914-17), the two revolutions (1917), the resumption of war (1918-19), and the famine (1919-23), Russia suffered more from starvation, civil disorder, physical and mental suffering than all the other nations combined, exhibiting a higher mortality from disease than she had sustained from the World War and the subsequent bloodshed. During the famine period, 10,000,000 died of starvation alone. The mental effect was a singular apathy, inability to concentrate, weakened will power, impaired memory, loss of affection, compassion, and the desire to be clean. Coincident with the second revolution and the famine was a gigantic incidence of communicable diseases. Typhus and relapsing fever were rare before 1914,

but after the war (1914-17) affected 35,000,000. Malarial fever, always rampant in Russia, affected 3,170,547 people in 1914. Through scarcity of quinine, the mortality reached 40 per cent. in some areas. Tuberculosis increased in all the combatant nations during and after the war. Pavloff believes that the conditions which have undermined Russian society are due to the throwing down of all moral restraints, in other words, the psychotic effects of extreme sexual license and of the Freudian repressions are identical in the long run. The customs, institutions and economic organization of the old régime were entirely obliterated. Communism was applied to every person, child or thing. There was a distinct lack of drugs and of doctors (1 : 5800), of whom one-third perished in the famine.

The period is one of endless mechanical inventions which save labour but destroy leisure. As we enter the machine age, the salient fact about medicine is the trend toward socialization. Few people in modern life can save money, even for doctor's bills, hence become easy victims of cultists and quacks.

There is not only lag and maladjustment of administrative machinery, but with a people so spontaneous as Americans, it may be scrapped or changed overnight if found too costly. In Germany, compulsory panel practice, health insurance (1887), and the many physicians' strikes in the German cities, led to the organization of a protective league of physicians against the en-

croachments of state-management of medicine. Since the war German medicine has moved rapidly in the direction of socialization.

Panel practice leads to careless prescribing.

Russian medical journals are preoccupied with socialized medicine. Connected with the Peoples' Commissariat of Public Health (1918) are the Soviet Central Scientific Institute of Public Health (1919). There are hospital provisions for up to 250,000 beds, but only one physician per 20,000 persons. The Röntgen Institute at Leningrad (under Professor Nemeneff) the largest in Europe, handles a tremendous clientèle and turns out 40,000 x-ray plates daily. There is a Health Resort Clinic, 25 Diet Kitchens for Diabetics and Dyspeptics, and night asylums (sanatoria) for vagrants.

The most effective of the Soviet methods of exploiting public, rural and personal hygiene is by way of brilliant polychrome posters, which, after the fashion of Indian picture-writing or the tavern sign, warn the illiterate peasantry as to the dangers of quackery, venereal diseases, industrial accidents, abortion, and sepsis. It is in Russia that the great future problems of social medicine will be tried out on a grand scale.

The status of medical education since the war has been carefully studied by Abraham Flexner (1925). At the start, he stresses the increasing trend toward elimination of superstition and speculation, the stationary, uncritical status of empirical medicine and the necessity of viewing clinical observation and laboratory experimentation as coequal, if medical education is to retain

a scientific quality. There are three kinds of medical schools, the clinical (English and French), university (German), and the proprietary (early American). It is, however, an expression of the difficulty voiced by W.J. Mayo, that the profession has on hand, at present, to much knowledge, cannot keep pace with it, and needs to have it organized.

A large number of talented women have developed as investigators, amongst whom are Mary Putnam Jacobi, who won a Paris Faculty medal for her thesis on acid and neutral fats, the late Mme.Déjerine (neurology), Maude Slye (Cancer), Gladys Dick (scarlatina), Dorothy Reed (Hodgkin's disease), Ruth Tunnicliff (measles, meningitis), Louise Pearce (experimental medicine); in England, Janet Lane-Claypon (ovarian hormones), and in Canada, Maude Abbott (congenital malformations of heart). Among those who have been promotors of infant welfare are Mary Lowell Putnam (Boston), Jane Addams, S. Josephine Baker, Ellen C. Babbitt, and Janet Lane-Claypon.

A matter of concern to preventive medicine is the remarkable increase in mortality from heart disease, pneumonia, nephritis, cancer, and tuberculosis. Infant mortality has been reduced 50 per cent. since 1908, and is now less a matter of diarrhoea and enteritis than of premature births from faulty antenatal hygiene and obstetrics. Weir Mitchell said that the treatment of neurasthenia and neuroses should begin with the preceding generation..

Some lift to the cause of international hygiene was attained at the International Convention of Health of the League of Nations at Geneva (May, 1926). For ages, Asia has been the matrix of the major epidemics and China has endemic

areas of all manner of diseases. The sanitation of these vast areas, if attainable, is one of the big problems of the future.

As with individuals, wars are "wished" upon friendly, peaceful (and therefore defenceless) nations, never upon those keen and able to defend themselves.

The ethical spirit is the palladium, the soul of medicine. "The future aim of medicine is that of any other science and identical with that of medicine at all times: It is the task of seeking and finding the truth, whatever it is and by whatsoever ways it may be found," (Wunderlich), in other words "Wherever the art of medicine is loved, there also is love for humanity" (Hippocrates). The ideal of preventive and social medicine is well described by Minot: "We have enthroned science in the imagination, but we have crowned her with modesty, for she is at once the reality of human power and the personification of human fallibility."

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